June 1949

Agriculture

The Journal of the Ministry of Agriculture

VOL. LVI No. 3

PUBLISHED 6d MONTHLY

HIS MAJESTY'S STATIONERY OFFICE

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck 7711*)

VOL. LVI No. 3 JUNE 1949

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Cover Photograph

Grass-fed Beef

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GRAIN STORAGE

Report of a Conference held at Maidstone on February 24, 1949

G. H. GARRAD

Kent Agricultural Executive Committee

MR. W. H. CASHMORE, Director of the National Institute of Agricultural Engineering, introduced the subject of the conference by saying that it is now generally accepted that the combine harvester has definite advantages over the self-binder. By its use one may expect to harvest more grain per acre and better quality grain. But as the number of combines increases so does the problem of drying and storing the grain.

This problem is tied up closely with the technique of operating the combine. During the war it was necessary for the Ministry of Agriculture to require that the limited number of combines available should cut the maximum acreage, and a fairly high acreage figure was expected of farmers when a combine was allocated to them. Experience has shown, however, that by using the combine a few hours less in the season one can reduce the need for drying. If one aims at 15 to 20 acres per foot of cut instead of 25 to 30 acres, a much larger proportion of the corn can be cut in such a condition that it requires very little or no drying. It is very difficult, however, to predict the weather in this country, and some provision should be available for drying damp grain as a safeguard against the occasional bad harvest.

The pressure of work in the harvest field can be eased by a careful selection of varieties of corn to extend the harvesting period. Many combine owners, in their anxiety to press on, are still guilty of starting to cut a field three or four days before the crop is ripe ; others wait until the crop is ripe and then carry on during a spell of damp weather when the corn is not sufficiently dry. The need for drying can be minimized by avoiding combining too early in the morning or too soon after rain, and by keeping on during meal times when the crop is dry. Wheat will stand after it is ripe better than barley, so if conditions are suitable for the combine to work and both crops are ready, preference should be given to the barley field.

Mr. Cashmore said that he had not had much success with windrowing as opposed to direct combining. A fairly extensive trial of the two methods was carried out in Oxfordshire, Worcestershire, Lincolnshire and Kent in 1946. Generally speaking, it was found that the rate of working was not appreciably increased by windrowing, and under some conditions a lot more labour was necessary. The total labour worked out at 7.8 man-hours per acre for the windrowed crop, as compared with 3.8 man-hours for the straightforward cutting. Losses of corn are much the same except with barley, where windrowing saved some corn. With laid crops, windrowing definitely increases the loss. One must have six inches of upright stubble on which the windrowed crop can lie, and there is not such a stubble in a laid crop.

In the case of oats there will be a higher feeding value in the straw if the crop is windrowed when still slightly green as compared with a crop which is left standing until it is dead ripe for direct combining. With a weedy crop, too, windrowing may be a real help in dealing with the green rubbish. But after a heavy rain which has soaked into the windrows a standing crop dries more quickly. Mr. Cashmore admitted, however, that the technique of his trials may have been faulty, and he is not yet prepared to give a final answer on this question of windrowing.

The moisture content of grain has been measured over a number of years. The temperature of the hot air should never be allowed to exceed the following limits, even for a few minutes :

	deg. F.
Oats and dredge corn, except for seed	180
Wheat for milling	150
Barley and seed corn containing up to 24 per cent moisture	120
Barley and seed corn containing over 24 per cent moisture	110
Linseed, mustard, and other oily seeds	115

A moisture-meter on the drying plant, although helpful, is not essential once a man has become experienced in judging the moisture content of grain.

For safe storage the amount of moisture in the grain should not exceed the following figures :

	per cent
Long-term bulk storage	14
Short-term bulk storage	14—16
Long-term sack storage	16—18
Short-term sack storage	18—20

In trials carried out in Bedfordshire during the wet harvest of 1948, 43.5 per cent of the combined grain contained more than 20 per cent moisture and needed drying ; 17 per cent contained more than 22 per cent moisture. When moisture exceeds 20 per cent, grain must be dried or turned until dry. About 40-60 per cent of combined corn requires drying, but much of it only needs the removal of 3 or 4 per cent of moisture

Grain driers are very expensive to construct and install on a farm, but they do their work well in making the grain safe for storage. Today, many have thermostatic control and the amount of grain damaged in drying is very small. Some merchants will condition corn for their customers, but this service is limited by the fact that merchants are unwilling to dry grain containing more than 18 or 19 per cent moisture because it is costly to dry, and they dislike taking grain at all hours of the day or night, especially at week-ends. One cannot, therefore, rely entirely on merchants.

Mr. Cashmore explained that there is a tendency for the manufacturers' figures regarding the capacity of their grain driers to be on the high side. The reason is that in the early days the capacity was calculated on the basis of drying at a temperature of 180°F. It was found that at this temperature some grain gets damaged, so the operating temperature is now reduced to 150°F. A drier rated at 2 tons per hour at a temperature of 180° F. will not dry the same quantity at a temperature of 150°F. The "tons per hour" is based on the assumption that 6 per cent moisture is taken out. A drier that removes 6 per cent moisture from a ton of grain at 150°F., will remove 4 per cent moisture from 1½ tons of grain in the same time. As the amount of grain dried per hour depends both on the temperature and on the amount of moisture to be removed, Mr. Cashmore suggested that in a normal season a 1-ton per hour drier working 10 hours a day can handle about 400 tons of grain in a season. Smaller driers are obtainable, but they are in comparison more expensive than the larger ones. For small farmers a co-operative drier is a possibility ; but it means double transport if the farmer wants his grain back, and there is the difficulty of keeping samples separate and of dealing with small quantities.

It should be borne in mind that in 1939 there were only about 150 combine harvesters in this country, that about 6,900 were in operation for the 1948 harvest, and that the number is continually increasing. So the drying and storage problem becomes more important every year. About 900,000 tons of grain were combined in the 1948 harvest.

A grain storage plant on the farm is costly but may be well worth while. One can either convert an existing building, which is usually a complicated and expensive business, or one can erect silos, either pre-cast or built on the farm. Concrete silos appear to be the best solution to the problem. It is unlikely that more than three-quarters of the grain combined will have to be stored; but even on a farm with only a small combine, at least six silos will generally be needed for separate storage of different kinds of grain.

Ventilation of grain in bulk by passing a trickle of cold air through the mass was tried as an experiment by the National Institute of Agricultural Engineering several years ago as a likely means of preventing grain from going mouldy until it could be dried in a standard drier. It was found that if the moisture content is above 23 per cent the grain cannot be held for more than a few days by this method, but that periods up to 21 days are possible with grain containing not more than 20 per cent moisture. The amount of actual drying, however, was small, so it was decided to carry out some trials with the use of heated air for ventilation. These experiments have culminated in the ventilated bin installation at Pitstone, Bucks, described by Mr. Hawkins (p. 96).

The principle of the ventilated bin is that air is blown through the grain at a temperature of 75° to 80°F. It is a slow process and is not suitable, therefore, for grain containing more than 20 per cent moisture, because such grain cannot be reduced to a safe moisture content quickly enough before moulds develop on the grain. The rate of drying is slightly more than at the rate of ½ per cent reduction in moisture content per day, which means that it would take about eight days to remove 4 per cent of moisture. The cost of operating, however, is very cheap (less than 6s. per ton) and the ventilated bins serve the purpose of both drier and storage silo. It is expected that there will be 15 or 20 of these plants erected in time for the 1949 harvest.

Whether a farmer dries his corn with a standard drier or whether he uses a ventilated bin, pre-cleaning to remove the green leaf or other green material mixed with the grain is an essential part of the equipment before drying starts. It is these small bits of greenstuff that are the real source of trouble, because they hold a lot of moisture, promote moulding of the grain, and also tend to prevent the free flow of air in any ventilating plant. The use of a pre-cleaner will save a lot of drying.

Experiments with drying in sacks have been carried out by the N.I.A.E. Two-bushel sacks, three-quarters full, have been placed on a grid constructed over an air duct through which passes a current of warm air which is forced through the grain in the sacks. With air at a temperature of 80° to 90°F. it is possible to reduce the percentage of moisture in the grain by 6 per cent in 6 hours. Care must be taken to see that the sacks completely cover the apertures in the grid. The experiments have indicated that it is unnecessary to turn the sacks during drying by this sack method, and this, of course, has an important bearing on the labour cost. The trials, however, are not yet completed and the method has not yet been tried out on a commercial scale.

A skilled man is not required to operate the ventilated bin or the sack drier, but a skilled man and constant supervision are necessary for the standard grain drier. The ventilated bin method and the sack drying method have the advantage that the grain can be dried to the right amount of

moisture ; most of the trouble with the standard drier arises not from the grain being overheated but from its being over-dried or under-dried. Before purchasing a combine a farmer should always consider how he is going to handle his grain when he has combined it and what he is going to do with the seed.

In reply to a question, Mr. Cashmore said that the maximum temperature that can be used for drying barley is 120°F. ; this allows for a slight variation, which one gets even with a thermostatic control. If the grain is very wet, a temperature of 110°F. should be the maximum, but if the grain is fairly dry and a large amount of moisture is not being removed, one can go up to 130°F. With most grain driers 1 per cent of moisture is removed in 8 to 10 minutes. If the moisture content exceeds 23 per cent it may be necessary to dry the barley in two, three or (in some cases) four operations ; there will be no harm to the barley, provided the temperature does not exceed 110°F. The maltster dries barley down to 11 or 12 per cent moisture for long-term storage in bulk.

Asked as to the relative cost of heating the air in a ventilated bin with electricity as compared with oil, Mr. Cashmore said that the cost of oil firing will probably be 40-50 per cent that of electricity, but in his opinion electrical heating installations are economical provided that the whole system is designed for using electricity. It is easier to maintain a constant temperature with an electrical installation than with oil or coke heating. Quite a lot of the drying is done by the air itself, and for a large part of a typical autumn day drying can be effected with a fan without having to use any heat at all. For those reasons he considered an electrical heating unit is economical for ventilated bins, but with a grain drier of orthodox type it is a different proposition. In the past, grain driers have been designed mainly for coke heating, but the question of efficiency has not been studied as seriously as it should be.

In reply to a question about the Claas combine, Mr. Cashmore said that it was designed in Germany to suit German conditions and that the design was influenced by the fact that the rye crop has to be harvested in the wetter parts of Germany and the rye straw is very long. He did not agree with the questioner that a seed-dresser on all makes of combine harvesters would be a good innovation, because the grain may not always be dry enough for proper dressing. It is sometimes a disadvantage to have both head corn and tail corn on the combine ; the proper place to clean corn is in the barn. As regards having the straw baler attached to the combine, the total cost may be less than having a combine and a pick-up baler as two separate machines, but straw is not always dry enough for baling as it leaves the combine.

Storing Grain in Ventilated Bins MR. J. C. HAWKINS described the ventilated bin installation that was erected, with the technical help of the N.I.A.E., on his father's farm, Green Farm, Pitstone, Bucks, in 1947. His father has a combine harvester with a 5-foot cut and grows 150 acres of corn a year in addition to various seed crops—linseed, sainfoin, clover, cabbage seed, etc. It was necessary to have some kind of storage and no buildings were available which could be adapted for the purpose.

As a result of the experiment referred to by Mr. Cashmore, it was decided to effect combine drying and storage in one operation and to have not less than six bins or silos ; with less than that it would not be possible to keep the different kinds of grain apart. The bins could not be made more than 10 feet above ground level, because 10 feet is the maximum depth of grain that can be ventilated properly. The bins were made circular, and the walls consisted of this reinforcement plastered with a rough rendering of

concrete made with quick-setting cement with an inner and outer finishing coat of cement mortar.

It was decided to construct the bins with flat floors because, although this arrangement is bad for emptying, it is much cheaper and easier to make. If one had self-emptying bins with a funnel-shaped base it would reduce the capacity of each bin by about 30 per cent. Each bin was made with a false floor of porous blocks supported on spaced bricks so that the ventilating air entered over the whole floor area. This arrangement was cheaper than using malt kiln tiles, as Mr. Hawkins was able to buy enough foam slag blocks for £26 to cover the bottom of all six bins, and there are enough left over for two more bins. A difficulty with malt kiln tiles is that the perforations are liable to get blocked with broken grains of corn, weed seeds, etc., and the only effective way of clearing them seems to be with a knitting needle. The bins were made circular because this was more convenient, but square ones would work equally well; the ventilation would not be affected in any way.

Air is driven through the bins at not less than 12 feet per minute. Two fans—a reverse-curve medium pressure fan for ventilating the bins and a paddle blade high pressure fan for conveying—were installed. Both were driven alternately from the same 10 h.p. electric motor. One might expect it to be cheaper to have one fan for both operations, but a ventilating fan has to be designed so that a lot of air at a low pressure is delivered through ducts into the bottom of the bins, whereas for conveying the grain a little air is required at a relatively high pressure. If one fan were used for both purposes it would be inefficient in both cases, taking more power than it should. It was decided that it would never be necessary to ventilate more than four bins at any one time, so the capacity of the ventilating fan and the size of the ducts were designed accordingly. Insulation of the air ducts so as to conserve heat is most important for economy and efficiency.

It was intended to have a pre-cleaner to take out all green material from the grain before it went into a bin, but it was not possible to get one before harvesting began.

The plant was completed by erecting a Dutch barn over the whole of it —fans, electric motor, bins, etc. Experience showed that a certain amount of rain was liable to blow in under the roof of the Dutch barn and get into bins through the top, but this difficulty was easily overcome by fitting some skirting around the barn.

The main structure was built in 1947 by a bricklayer and his labourer with the help of labour already on the farm. The total cost worked out as follows:

	£	s.	d.
Materials	167	9	11
New machinery	311	5	8
Labour	220	19	2
Dutch barn	310	0	0
Total	£1,009	14	9

The total storage capacity of the plant is 150 tons, which works out at nearly £7 per ton of grain stored. If the erection had been carried out by outside labour the cost would probably have exceeded £10 per ton. A full report of the plant has been published by the N.I.A.E. in the *Agricultural Engineering Record*; reprints of this report are obtainable on application either to the N.I.A.E. at Silsoe, Bedfordshire, or to the County Advisory Machinery Officer (Mr. G. B. H. Spear) at Mote House, Maidstone, Kent.

The plant was ready for use in time for the 1947 harvest, but the weather was so favourable that it was hardly used at all. For the 1948 harvest it was invaluable, since there were 168 acres of corn, as well as various seed crops, to harvest in very unfavourable weather.

When the corn needs only a very little drying the bins can be filled to capacity, but if the grain is very damp it is better to half-fill two bins and pass air through, heated about 10°F. above atmospheric temperature, until the grain is dry enough to put the two lots together.

The percentage of moisture in the grain as it arrived at the plant varied between 15.3 per cent and 24.5 per cent and averaged 19.2 per cent moisture. Moisture was removed until it was brought down to 16.25 per cent. The total amount of corn dried in the 1948 harvest was 166 tons, and the total amount of water evaporated was about 6 tons.

The cost of electricity was 1.7d. per unit for power and 1.1d. per unit for heat and amounted altogether to £40 1s. (£27 for power to drive the ventilating fan and £13 for heating), or 4s. 10d. per ton of grain. No actual figures of labour costs are available, but Mr. Hawkins estimated that drying cost, for labour and power, without overheads, would be about 5s. 4d. per ton.

Oil or coke heating may be cheaper than electricity but it is easier to maintain a constant temperature with an electrical installation, and Mr. Hawkins pointed out that in this installation quite a lot of the drying was done by the air itself on warm sunny days, without having to use any heat at all. The total electrical current used was 3,820 units, of which about one-tenth was used for conveying and the rest for ventilating and heating.

In reply to a question whether the expense of the Dutch barn could not have been avoided by fitting a roof over each bin, Mr. Hawkins said that everything had to be put under cover—bins, pre-cleaner, fans, electric motor, etc.—and in his opinion it was more convenient and cheaper to have them all under one roof.

Asked how long the grain could be stored, Mr. Hawkins replied that provided the moisture was reduced to 16 per cent or less, the grain in a ventilated bin could be stored indefinitely. One of the advantages of having a ventilated bin is that if the farmer is doubtful about the condition of the grain he can switch on the ventilator fan and it is then possible to tell from the condition of the air after it has passed through the grain whether or not the grain is in good condition. One can always turn a bin pneumatically if one is worried about its condition.

Asked whether grain would not suffer damage when moved through a pneumatic conveyor Mr. Hawkins said that it is quite possible to damage some grain, especially if the end of the conveyor directs the grain on to the side of the bin. When starting to fill the bin a small quantity of grain will strike the bottom of the bin, but in a very short time the incoming grain will fall on to the grain already in the bin and very little damage will result.

Another questioner asked whether dry grain could not be drawn off from the bottom of a ventilated bin and conveyed to another silo which was not ventilated and so save the cost of having so many ventilated bins. Mr. Hawkins replied that the grain would tend to "funnel" because the bin outlet is at the edge of the bin. Even with the opening in the centre and a funnel-shaped base to the bins, it would still not be possible to draw off the dry grain at the bottom because of funnelling in the bin.

Standard Drier and Bins MR. R. O. ANDREWS, Chalton Cross Farm, Luton, Bedfordshire, said that many farmers have the idea that installing a drier and storage arrangements involves the expenditure of many thousands of pounds. But they can be put up much more cheaply than that. Not only will they justify their cost in the saving of labour and the extra return received for the grain, but they will also put the owner in the position of being able to hold his grain against a low or falling market.

GRAIN STORAGE

In the opinion of Mr. Andrews, with the ever-increasing number of combines, farmers who do not make arrangements to store their grain will be driven to accept a low price for their corn at harvest ; and even then they may not be able to move it off the farm for some time. With the expansion programme it is probable that more grain will have to be stored on the farm for feeding to livestock. For these reasons, and the feeling of security and independence which follows from the ownership of a grain drier and storage plant, it is good business for every combine owner to put himself into a safe position by having one. The proper place to store British grain is on British farms, but it is up to farmers to market their grain in proper condition and at the proper time ; the day for marketing grain in damp and poor condition has passed.

The installation of a drier and storage can be a very expensive business if it is not properly planned and tackled in the correct way. Mr. Andrews' plant was largely built with farm labour. In 1944 he purchased eight precast concrete silos, 14 feet internal diameter, to hold 250 quarters each at 17½ feet high at £71 apiece ; today they would cost £90 apiece. He also bought a pneumatic grain elevator for £66 ; today's price would be £90. In 1945 he bought an automatic weighing machine, capacity 252 lb., for £160, which today would cost £305. A dressing machine was bought for £185 ; today's price would be £290. He also bought a grain drier for £460 which today would cost £750. This grain drier was converted to electric heating at a cost of approximately £300.

Mr. Andrews gave the total cost of his plant for drying and storing 2,000 quarters of grain, with electric motors and extra ducting, at approximately £2,000. This figure does not include any building or installation costs, as all this work was done by his own farm labour in slack periods during the winter months.

He pointed out that capital today is cheaper than labour, and that £2,000 invested at 3 per cent comes to about one-quarter of one man's wages for a year. One must spend money, he said, to do the job properly and to make money. All the moving of his grain from drier to silo is done by pneumatic elevation ; it is automatic and no human effort is required.

The pneumatic elevator does the filling of the silos, turning from one silo to another, emptying silos back to the automatic weigher for sacking off, and back to the wet grain pit for re-drying if necessary. It will turn 60 tons of grain from one silo to another for a cost of 7s. for electric power and can be left running all night without attention.

In Mr. Andrews' opinion electricity provides the ideal means of heating and controlling the air temperature in the grain drier, but it is dearer in running costs than oil. His electric heater has a thermostatic control, so that the air temperature is automatically maintained constant, fumes from the combustion of coke or oil are entirely eliminated, and the air that passes through the drier and the grain is free from taint.

Mr. Andrews pointed out that driers are not "ripening machines" and that grain must be fully ripe before the combine goes into the field ; grain cannot be ripened after it has been threshed. Farmers should remember that the grain is alive. He estimates the temperature of the grain in his silos by putting a steel rod three-quarters of an inch in diameter into the grain and leaving it there. Each morning the rod is pulled out and by running it through his hand the operator can judge the temperature of the grain. It is a simple method but quite effective. The danger period of overheating is the first two or three weeks when the grain is in the silos.

In reply to a question as to the maximum depth of grain that can be put into a silo, Mr. Andrews said that provided the moisture content is brought

down to 15 per cent, it is quite safe to have a silo up to 17½ feet high. When pressed for room he has sometimes stored grain containing 16 to 17 per cent of moisture in these silos, but if this is done it is necessary to inspect the condition of the grain in the centre of the silo frequently and to be prepared to move the grain often from one silo to another. The air space between the blocks of the pre-cast silos helps with the storage.

Mr. Andrews, in reply to another question, said that the capacity of his conveying system is 45 cwt. per hour, but it is sometimes possible to work the drier faster in dry weather. If he were going to do the job over again he would install a conveying system capable of handling 4 tons of grain an hour to be on the safe side.

On the question of windrowing, Mr. Andrews said that oats are a crop that could be windrowed with advantage, especially if there is a lot of rubbish in the straw.

Sack Storage Mr. N. D. REFFELL, Court Farm, Dorney, near Windsor, dealt with the subject of grain storage from the point of view of the smaller growers who have had no experience of combining and whose grain acreage does not warrant the capital outlay on an expensive plant.

Mr. Reffell has been combining for three seasons and has been able to manage quite successfully without the aid of a drier or silos. He farms 370 acres in the Thames Valley, all arable except 10 acres. His principal crops are potatoes, barley, oats, wheat, and pedigree grass seeds and clovers. The average rainfall in his district is 2.1 inches in August and 1.8 inches in September, but during the 1946 season it was 4.08 inches and 3.60 inches, and in the 1948 season 2.54 inches and 1.74 inches. This heavy rainfall makes the harvesting of cereal crops a difficult proposition.

In his first season with a combine (1946) he found that the grain was blown over the cleaning sieves when he tried to make a clean sample ready for sale direct from the machine. So he had to reduce the wind current. He then found that the threshed grain was not clean enough to dispose of because it contained short pieces of straw, bits of stubble, weeds, thistle heads, etc., so he took it to the barn and cleaned it with an old winnowing machine bought at a local farm sale for 4s. In that way he is able to take care of the waste and either use it at home or sell it for chicken feed instead of losing it in the field. His winnowing machine is driven by a 2 h.p. petrol engine and can clean ten 4-bushel sacks per hour, one man feeding the hopper and another sacking up and weighing.

By leaving the uncleaned grain standing in the sacks for 24 to 36 hours before cleaning, Mr. Reffell is able to take out the more "sappy" pieces, e.g., tare pods, short pieces of green weed, stalks, green thistle heads and the like, also quite a large proportion of green immature grains. During these 24 to 36 hours of standing this green material wilts and loses some of its weight, so that it becomes lighter and separates much more easily from the grain than it would do without this period of standing.

Before attempting to store the grain, either before or after cleaning, very great care must be taken to see that it does not contain too much moisture. Mr. Reffell trusts to the old-fashioned method of pushing his hand well into a number of sacks, biting a few grains now and again, and using his judgment and considerable experience. Farmers who do not possess the necessary experience can get the N.A.A.S. to carry out moisture tests for them.

Having satisfied himself that the grain is sufficiently dry for sack storage, Mr. Reffell arranges the sacks in rows with spaces apart and three sacks high. Care must be taken not to let the sacks come in direct contact with a con-

crete floor, otherwise the sacks become damp and the bottom soon rots. Old paper fertilizer bags are useful for standing the corn sacks on, as the inside lining of these bags is water-proofed. Sisal paper is also a suitable floor covering, or rolled out chestnut pale fencing, or wooden boards if they are available.

Grain stored in this way can be kept successfully until the spring. Steps must be taken to control rats and mice. Vermin damage can be very serious when hessian bags cost up to 1s. 8d. each and 4-bushel corn sacks up to 6s. and 8s. each, apart from the loss of grain and unnecessary work of cleaning up, re-weighing and sack mending.

The success of Mr. Reffell's harvesting and grain handling method is reflected in the fact that the lowest price at which he has sold barley this year is £5 5s. per quarter, and at least half the sales reached the maximum price. The secret lies in Mr. Reffell's very careful judgment as to whether a crop is ripe and whether it is dry before starting the combine in the field. His advice is:

"Don't be over-anxious to start. Because your neighbour has started cutting with his binder it does not mean that you can start with your combine. If you feel that you are getting left behind don't forget that the crop harvested with a binder has to stand in stook and then be carried, stacked and threshed. If you hope to use a combine without a drier you must wait until all the grain in the field you are going to harvest is ripe. If it is not ripe and dry, no winnowing machinery can ripen it or do very much towards drying it, and your storage troubles will be endless. Don't start work too soon after a shower of rain. Standing corn dries quickly, but don't expect it to dry too quickly. If you start too soon, the moisture content of the grain will be too high and you will have some damp grain to shoot out on the barn floor or to get dried in some other way. Don't start work in the morning before the dew has dried off. It is very seldom advisable to start work before 10 a.m. on the nicest summer mornings because of the dew which usually accompanies these mornings. On dull days it may be necessary to delay starting work until late afternoon or evening."

Mr. Reffell has an arrangement with his drivers to be on call on Saturday afternoons and Sundays at very short notice during the harvest season, so as to avoid losing a few hours of good working conditions. He has relief labour to take over the tractor and combine during meal times, otherwise two valuable hours of work can be lost. A man who owns a drier need not be quite so particular about the conditions under which his combine works, but for a man who has no drier it is all-important.

It has been Mr. Reffell's experience during the past three seasons that an 8-foot combine can be used successfully on up to 200 acres of grain crops without the aid of a drier or special cleaning plant. Some careful thought must of course be given to the varieties of cereals sown and the time of sowing, so that the season of ripening is extended as long as possible. One might, for example, sow one-third of one's barley acreage with Pioneer in the autumn, one-third with Abed Kenya in the early spring, and follow with Spratt or Plumage-Archer. In an average season there may well be a few days to a week's difference between each of these varieties ripening. Similar thought should be given to the choice of varieties of oats and wheat.

Mr. Reffell pointed out that his method involves the use of very little machinery and no expensive equipment—only an appreciation of the situation coupled with the use of commonsense. He recommended his method of storing in sacks to growers of a small acreage of corn. It does not involve expenditure of capital on machinery and equipment that has to lie idle and unproductive over a great part of the year.

Mr. Reffell concluded with the following warnings :

Don't try to make a clean sample direct from the combine. It is quite easy to clean the grain in the barn and far less wasteful than trying to make the combine do the cleaning.

Don't leave uncleaned grain in sacks more than twenty-four hours if it contains a large amount of crushed clover leaf, leaves of sow thistles or any other sappy material ; otherwise it may heat in the bags and the grain will suffer.

Don't think that grain in any condition as regards moisture content can be safely stored in sacks. The combine must be used with discretion. This restriction will not please a contractor whose main objective is acres per day.

Don't store sacks for any length of time on a concrete floor without first putting down a damp-proof floor covering.

Don't start to combine a crop before it is dead ripe and free from external moisture such as dew or rain. If you have unripe or damp grain and no drier you are in serious trouble.

Don't aim at too big an acreage with your combine. If you do, you will be working it when conditions are not quite suitable and then your cleaning and drying troubles will begin.

Don't sow your whole acreage with one variety, so that all the fields ripen at the same time. Spread your harvest and so avoid waste and unnecessary worry.

Summing Up Mr. C. E. Elms, Provincial Machinery Advisory Officer for the South East Province, in summing up, emphasized the fact that in addition to the 6,900 combine harvesters in use in this country last harvest, it is expected that another 2,000 combines will be available for the 1949 harvest and a further 2,000 combines for the 1950 harvest. The question of drying and storage, therefore, becomes more and more acute. He calculated that if each combine had an 8-foot cut and harvested 20 acres per foot cut, the 2,000 new combines would deal with 320,000 acres of corn and would need 3 million bags. He wondered where these additional bags were coming from.

The conventional type of drier with storage silos is satisfactory, he suggested, for the large farmer, but at today's prices he estimated that the cost of installing a drier, etc. and storage for 4,000 quarters of corn would be about £10,000. Something cheaper must be found for the smaller man.

For a man like Mr. Hawkins, with 150 to 200 acres of corn, the ventilated bin system seems to be the answer. He had obtained some up-to-date figures from a contractor who admittedly was branching out on a new line of business, but this contractor estimated that the cost of the bins, heating and everything else, but excluding the Dutch barn, would be about £1,100, especially if outside labour is used to do the construction work. He had seen a quotation put forward by a constructional engineer for erecting ventilating bins, and the reinforcement alone, using expanded metal, came to £40 for each bin. The total cost of the ventilated bin plant today, therefore, would be rather more than Mr. Hawkins' plant had cost him.

He suggested that there is room for some other form of heater to be designed for warming the air which ventilates the bins, because it is not every farmer who has electricity. He had made inquiries and ascertained that some oil burner manufacturers are prepared to fit an oil burner for £95, but this does not include a furnace, which would cost another £35. He thought that two more storage bins might well be added to Mr. Hawkins' plant, as his existing fan is quite capable of dealing with a further 50 tons of grain. Mr. Hawkins had never found it necessary to ventilate more than three bins at any one time and the average had only been two.

The man who is really going to be in difficulty, Mr. Elms suggested, is the small man with 60 to 70 tons of grain to store. For him, sack storage seems to be the solution.

COMMUNAL GRASS DRYING IN ENGLAND AND WALES

RESULTS FOR 1948

H. G. LAMBERT

Ministry of Agriculture and Fisheries

THE nineteen communal grass drying centres dealt with in this note are those set up by Government grant under the scheme announced in February, 1948, including one centre at Thornbury, established in 1947. The service was experimental, both as regards technique and the recording of results. There is, therefore, no uniform and comprehensive set of records, on the lines, for instance, of those issued by the Dutch Government for approved centres in that country*. Certain data were collected, however, and are now published for the information of those interested in this experiment.

It would be unwise to draw any firm conclusions from the figures at this stage, and no attempt is made to do so. They are useful not only as a statement of fact but as showing the wide variations from centre to centre in the principal items, such as cost per ton, total output, and protein content. We have a long way to go before these variations can be explained in terms of climate, form of organization, size of centre, and so on.

The Board and Co-operative Societies responsible were :

	No. of Centres
Milk Marketing Board	12
Cheshire, Shropshire and North Wales Farmers' Supply Association Ltd.	2
Gower Farm Services Ltd.	1
West Cumberland Farmers Ltd.	1
Wiltshire Farmers Ltd.	3

These bodies provided a grass drying service to neighbouring farmers, and centres were subject to inspection by the Ministry of Agriculture and Fisheries. Except for a small percentage, the whole output was returned to the farmers contributing grass or forage crops to the station.

The results are shown for the different centres by number, with an indication of the size of the plant, and are in two parts—first, the data on output, etc., provided by the organizations, and secondly, protein content measured after sampling by the National Agricultural Advisory Service and analysis in their laboratories ; the objective was to take three samples per week, but in some cases this number was not reached owing to pressure of other duties.

The types of drying plant included tray, conveyor, and high temperature (rotary drum). Plant listed as "small" indicates one drier normally regarded as being capable of an output of 4 cwt. per hour of dry material under average moisture conditions. A "medium" plant refers to one or more driers capable together of an output of between 8 and 10 cwt. per hour, and "large" plant indicates a corresponding figure of the order of 15-20 cwt. per hour.

The most striking features are as follows : costs per ton (Table 1) run from £13 to nearly £23 per dry ton. Taking the largest compact group (i.e., medium size) centres, we have the total output for the whole season ranging from 300 to 1,200 tons ; and low costs per ton are usually accompanied by high output. Note that cost means the cost to the farmer of the *service* provided, which was usually the complete service of grass harvesting, collecting and drying, and transport to the farmer.

* *Agricultural Information Service*, No. 4 (April, 1948). Dutch Directorate of Agriculture.

COMMUNAL GRASS DRYIN

Table 1

Data Provided I

	Unit	Medium Plants								
		1	2	3	4	5	6	7	8	9
Throughput	tons	1,195	719	715	1,010	566	744	575	855	54
Cost per ton (estimated)	£	13.0	22.7	18.8	13.8	22.2	15.5	22.5	17.6	21.7
Working days	No.	161	158	153	167	137	139	150	155	137
Man-hours per ton	No.	28	35	34	32	41	41	42	30	55

(a) none given

Table 2

Protein Content of Dried Grass: May-Octob

(a) Percentag

Grade	1	2	3	4	5	6	7	8	9
A and B (over 15 per cent	11.6	26.2	6.5	14.3	17.2	12.9	14.0	13.9	31.8
C and D (11-15 per cent	53.6	51.3	43.5	46.9	48.3	50.0	49.6	52.8	40.9
Ungraded (under 11 per cent	34.8	22.5	50.0	38.8	34.5	37.1	36.4	33.3	27.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(b) Average Protei

	1	2	3	4	5	6	7	8	9
Protein Content (average of all samples at each centre)	12.7	13.1	11.4	11.8	11.9	12.1	12.0	12.4	13.0

Note : Figures relate to per cent crude prote

ENTRES: 1948 RESULTS

M.B. and Societies

					Small Plants			Large Plants		Total
10	11	12	13	14	15	16	17	18	19	
542	700	833	378	304	427	116	274	845	1,509	12,852
1.1	17.2	17.7	20.0	20.0	20.0	17.0	20.0	20.0	20.0	—
172	172	171	127	114	132	146	122	166	166	—
34	43	40	14.5	13.9	26.2	(a)	29.7	(a)	(a)	—

clusive (from samples taken by N.A.A.S.)
Grades

10	11	12	13	14	15	16	17	18	19	Average all Samples all Centres
10.8	16.0	12.5	32.0	24.0	8.9	40.9	11.9	12.7	14.5	18.4
27.4	48.0	50.8	48.0	56.0	55.7	46.9	66.1	34.6	38.1	46.3
31.8	36.0	36.7	20.0	20.0	35.4	12.2	22.0	52.7	47.4	35.3
00.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

ntent

10	11	12	13	14	15	16	17	18	19	Average
14.1	12.8	11.7	13.5	12.9	11.9	14.4	12.3	11.7	11.5	12.4

sample on 90 per cent dry matter basis

The next significant point is the range of protein content by centre (Table 2). In the top quality, for instance, centres have from less than 7 per cent to more than 40 per cent of the samples taken ; on the other hand, there is a certain degree of uniformity in the proportion below the datum line for grading purposes ; i.e., below 11 per cent crude protein content (on a 90 per cent dry matter basis).

The figures below show the monthly variations of protein content. In noting the gradual rise in the relative proportion in the higher grades, allowance must be made for the fact that building delays meant a late start at many centres and the organization was not running smoothly until late in the season :

Grade	May	June	July	Aug.	Sept.	Oct.
A and B (over 15 per cent)	6.6	4.0	12.6	30.4	26.1	31.1
C and D (11–15 per cent)	44.3	24.3	36.1	59.3	59.0	57.7
Ungraded (under 11 per cent)	49.1	71.7	51.3	10.3	14.9	11.2
	100.0	100.0	100.0	100.0	100.0	100.0

A footnote is necessary on the measurement of protein content. The scale adopted by the Advisory Service relates to samples of dried grass approximately as received (for the sake of uniformity reduced to a common basis of 90 per cent dry matter). Some authorities quote the crude protein content of dried grass on a 100 per cent dry matter basis, which would mean applying a factor of 10/9 to the above figures, e.g., the top average of a centre of 14.4 per cent for the whole season is equivalent to 16 per cent on the 100 per cent dry matter basis.

Estimated figures of man-hours per ton are included ; but these should be regarded with some reserve. The basis of computation is not necessarily uniform between organizations, and in the first season it was necessary to experiment to determine the exact labour force required for the different types of plant.

POTATO SILAGE

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INVESTIGATIONS into the making of potato silage were first started at the Kirton Agricultural Institute in May, 1930, when surplus potatoes from the 1929 crop were incorporated with a green crop in a stack or clamp silo by the method described later in this article. The silage was fed to bullocks during the winter of 1930-31, and as a supplement to fattening cattle on grass during the following May, June, and July. The clamp was then closed, and re-opened in November. The silage had kept in good condition, and was readily eaten by stock.

Mixed silage of this kind is not suitable for feeding to pigs. For pig feeding the potatoes should be cooked, either by boiling or steaming, after which they can be ensiled in a concrete silo or in an outdoor pit silo. Properly made steamed potato silage will keep in good condition for two years or more.

POTATO SILAGE

From 1931 to 1939 steamed potato silage was made each year at Kirton for feeding to pigs, and it was found to be profitable to buy surplus potatoes for the purpose. They could be bought at £1 per ton or less, at which price they were much cheaper than barley meal. Four tons of potatoes are equivalent in feeding value to one ton of carbohydrate meal, so that at today's prices, when the cost of ensiling is added, they are slightly cheaper than barley meal.

There are three ways of making potatoes into silage: (1) by incorporating layers of tubers with a green crop in a clamp or stack silo, (2) by cooking the tubers, and placing them in an outdoor pit silo, and (3) by slicing the raw tubers, mixing them with a little fermented meal, and placing in a pit silo.

Method 1 cannot be used until towards the end of May, when a green crop becomes available. Silage made by this method is suitable for bullock feeding, but not for pig feeding. Method 2 may be adopted at any time when potatoes are available. Partly blighted tubers may be preserved by this method. Silage so made is especially suitable for pig feeding.

1. Admixture of Potatoes and Green Fodder Silage composed of potatoes and green fodder has been made successfully on several farms in Lincolnshire, and bullocks fed with it made better progress than others fed on a normal, standard ration. The cattle readily ate the silage, and no trouble was experienced from its use.

At the Kirton Institute farm, some years ago, about 40 tons of seed and chat potatoes were mixed with the produce of about 9 acres of a one-year's clover and ryegrass mixture. This crop was cut in the middle of May, and with fine weather the green crop was carted immediately to a levelled site. A layer of green crop, 1 foot thick, was spread evenly over the ground. A layer of 1 ton of potatoes, previously riddled to remove soil and sprouts (and bagged for transport to the silo), was then spread evenly over the green crop. A run-over heap was made to secure the necessary consolidation. The green crop and potatoes were placed in alternate layers When complete, the sloping ends or ramps were cut away and the material thrown on the top. The following day a layer of about 6 inches of soil was placed evenly over the top and, a few days later, the sides also were covered with soil. Another layer of 3 inches of soil was also placed on the top.

When the silo was opened very little wastage was found. The mixed silage smelt sweet and pleasant, and where the heat had been greatest the tubers were partly cooked and quite sweet. Where there had been less heat, the tubers were white in the flesh and slightly tough. There was practically no seepage from the silo.

FEEDING TRIAL To test the value of the silage against an established method of feeding, six Lincoln Red bullocks were divided into two lots, and a ration of similar balance (in so far as the nutrient qualities of the silage could be estimated) was fed to each. The starch value and protein equivalent of the silage were the only nutrient factors unknown, but the figures would appear to be approximately: starch value, 17; protein equivalent, 1.4. The basis of the ration in one case was potato and green fodder silage, and in the other sugar beet pulp. The bullocks consumed the silage eagerly. The silage-fed bullocks were of better appearance, they handled better, and their skin was softer and more pliable than those in Lot B. It is of interest, too, that both lots made equivalent liveweight gains per day.

The following Table shows the average liveweight figures per bullock :

	Initial Live Weight			Final Live Weight			Gain per Day
	cwt.	*qr.*	*lb.*	*cwt.*	*qr.*	*lb.*	*lb.*
Lot A (Silage)	10	1	18	12	2	0	1.63
Lot B (Beet pulp)	10	1	9	12	1	18	1.63

2. Potatoes Steamed and Ensiled in a Pit Silo A pit 6 to 7 feet wide, 2 feet 3 inches to 2 feet 6 inches deep, with sides sloping slightly inwards, should be prepared on dry ground conveniently near the feeding pens. If water is likely to be troublesome, means should be taken to get rid of it. The potatoes should be cooked in a steamer or copper, and then well packed into the pit to avoid large air spaces. They should be built up well above ground into a ridge in the middle, as in an ordinary potato clamp. The sides and top of the ridge should then be covered with straight straw, and sealed with about a foot of soil.

Potatoes made into silage this way may be fed to pigs without any further preparation. Trials have shown that pigs readily consume this silage, and that thus fed they do as well as pigs fed on meals or standard balanced rations containing freshly-steamed potatoes.

3. Raw Potatoes Sliced and Mixed with Maize The steaming of potatoes adds to the cost of feeding, and for cattle it is neither necessary nor desirable. The potatoes can be sliced in a root pulper, and placed in a pit similar to that described under Method 2, together with a small quantity of fermented maize or barley meal.

The maize or barley meal should be prepared two days previously. It should be thoroughly saturated, but not made sloppy and allowed to become sour before being mixed with the potatoes. About 5 per cent by weight of soaked meal is required (approximately 1 cwt. per ton). The meal will increase in weight by about 75 per cent when soaked.

The pit should be finished off as already described. Silage thus made was readily eaten both by cattle and pigs.

Conclusions and Recommendations Experiments at Kirton have shown that (1) silage made from raw potatoes and green crop in alternate layers is suitable for feeding to fattening cattle, and (2) potatoes either freshly cooked or ensiled may safely replace carbohydrate meals in pig feeding, but they must be introduced gradually into the ration. They must not be fed in large quantities to young pigs. These should be weaned on to a full ration ; thereafter a few potatoes may be introduced, and the allowance gradually increased. When four months old they may be brought on to a full potato ration, that is to say, the whole of the carbohydrate part of the ration may be replaced by potatoes.

As potatoes contain a smaller quantity of protein than the meals replaced, it is desirable to adjust the balance of the ration if the best results are to be obtained.

Potatoes may be fed to suckling sows in moderate quantities, if introduced into the ration 14 days after farrowing.

In-pig sows may be fed on a ration containing potatoes, but the quantity should be reduced as pregnancy advances, and omitted about 14 days before farrowing.

It should be stated that there is considerable shrinkage in ensiled potatoes. Watson* states that nutrient losses in outdoor, unlined pit silos are comparable to those with other materials. An experiment at Kirton suggested that 3 lb. of ensiled potatoes is equal in feeding value to 4 lb. of freshly-steamed potatoes. Further investigation is, however, required into this point.

It is recommended by some authorities that potatoes should be washed before being ensiled. We have never found this necessary at Kirton, but it may be in areas where much soil adheres to the tubers.

FLOODS AND THE SPREAD OF POTATO ROOT EELWORM

H. W. Thompson, A. Roebuck and B. A. Cooper
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THE thaw which followed the exceptionally heavy snowfall in February and March, 1947, resulted in the first place in the waterlogging or actual flooding of large areas of country. This was followed in some places by the bursting of river banks, and escaping floodwater swept across adjoining land with consequent scouring and washing away of vast quantities of surface soil, much of which was later deposited a considerable distance away. Much of the flooding occurred in the main potato-growing areas, and it was feared, therefore, that the rush of water over this land, which included considerable areas known to be infested with potato root eelworm, might have resulted in the widespread distribution of the eelworm, and that fields previously free might now be infested. This position arose in three provinces, in each of which an attempt was made to determine to what extent eelworm distribution had been affected as a result of flooding. In the Selby district, where the cereal root eelworm is also prevalent, and in the Nene and Welland areas, where the sugar beet eelworm is a problem, the investigation was extended to include these species. The areas studied were Selby (River Ouse), Trentside, Fens of Kesteven (R. Witham), the Crowland area (R. Welland), and Sutton Bridge (R. Nene).

River Ouse. The part of Yorkshire most severely affected by the floods was the area around Selby, where the Yorkshire Ouse burst its banks and flooded many square miles of country carrying a large acreage of potatoes every year and where eelworm is common.

River Trent. A large area of the Trent Valley, north of Gainsborough, was flooded when the Trent bank broke north of the village of Morton. The general direction of flow of the released water was northwards, parallel to the river, reaching to Keadby Bridge. Five or six miles north of Morton is an area around East Ferry that has had potato sickness for an appreciable number of years. This area was in the direct course of the flood stream, and was itself inundated for four or five weeks.

River Witham. The flooding in the Fens of Kesteven along the River Witham to the south-east of Lincoln was of a different nature from the flooding along the Trent Valley. This part of the country is intersected by many dykes or "delphs," which overflowed as the volume of water

* *The Science and Practice of Conservation—Grass and Forage Crops*, **1**, 404.

increased. As the level of the delphs became lower, the water gradually made its way back to them, only to come out again as more water came down from the Lincolnshire Heath. This overflowing with the return of the water occurred three or four times before the water was finally cleared.

River Welland. Following the exceptionally high rainfall of the summer and autumn of 1946, the soils of North Fenland (the North Level) were unusually wet. Cowbit Wash is an area of grass some nine miles long and up to one mile wide, lying beside the River Welland, bounded by high banks built to collect and store up water coming down the Welland and to allow it to flow to the sea between tides when floodwaters have subsided. As a result of the provision of a new pumping station, Cowbit Wash had been dry during the previous four winters but became a lake again during November, 1946, and remained so until the thawing of the snows in March, 1947. On March 21, 1947, the banks of the Cowbit Wash opposite Deeping High Bank broke, and, as a result, between 15,000 and 20,000 acres of arable land in Holland, Kesteven and Peterborough were flooded, over most of the area to a depth of a foot or two and in some cases to a depth of many feet. The inundation reached its maximum expanse about April 10. The rush of water through the breach dug a hole 30 feet deep outside its banks, and many lumps of clay and soil from this vicinity were spread over fields within a quarter of a mile around, and the finer material was carried much greater distances. The area normally carried about 30 per cent of its arable area in potatoes, and a great many potato and mangold clamps were washed away, along with corn and straw stacks and other farm materials.

River Nene. Much of the water from the Crowland breach found its way, not back into the Welland, but into the River Nene a few miles above Sutton Bridge. Eelworm cysts found in the samples examined below Sutton Bridge may, therefore, have been brought by waters emanating from the Welland, and which passed through an area heavily infested with potato root eelworm before reaching the Nene.

Sampling Data Samples of material deposited by the floods were collected in the three provinces involved and examined for the presence of cysts of the potato root eelworm.

Ouse Area: Grassland. To ensure that samples were taken only from fields where infestation did not occur originally, permanent grassland was chosen and sampling was restricted to the silt deposited on the surface by the floodwater. Composite samples of silt taken from several points at each site were collected. The normal flotation technique was employed for cyst counting and, in addition to recording the potato root eelworm (*Heterodera rostochiensis*), counts were made of the lemon-shaped cysts of the cereal root eelworm (*Heterodera major*), also prevalent in this region. Samples were taken at random throughout the affected area, and no attempt was made to select sites adjacent or near to known centres of infestation.

Many of the samples, as was to be expected, showed no eelworm cysts present, particularly of the potato root eelworm type. Out of a series of ten silt samples, collected from fields in seven parishes, only at one centre was this eelworm found, while five centres showed substantial counts of cysts of the cereal root eelworm. Detailed counts are shown in Table 1. This series of samples, although indicating that eelworm cysts can be distributed by floodwater, gave little evidence of considerable distribution of potato root eelworm.

Table 1

Samples of Silt deposited on Grassland by Floodwater

	Centre	Wt. of Sample Examined	Potato Eelworm Cysts	Cereal Eelworm Cysts
		grm.		
1.	Cawood	40	0	0
2.	Wistow	40	0	0
3.	Hemingbrough (a)	40	0	10 (3 viable)
4.	Hemingbrough (b)	40	0	8 (3 viable)
5.	Hemingbrough (c)	40	0	4
6.	Kelfield	40	2 (2 viable)	0
7.	Stillingfleet	40	0	0
8.	Barlby	40	0	7
9.	Escrick (a)	40	0	0
10.	Escrick (b)	40	0	4

OUSE AREA : DEBRIS. The normal method of cyst counting from soil samples depends on a flotation process. It was thought, therefore, that cysts might well be carried for considerable distances and deposited with other flotsam. In many instances large quantities of straw and other debris were deposited at the highest point reached by the floods, leaving a sharply defined high-tide mark across fields where flooding had occurred. Representative mixed samples of this material were collected and examined as before for the presence of cysts. As with the first series, samples were taken only from grassland, where normally infestation would not be expected to occur. These samples contained considerable numbers of cysts of both potato root eelworm and cereal root eelworm. The counts obtained, however, are not directly comparable with those of the first series, since, because of their strawy nature, the samples were very light in relation to their bulk.

A series of twelve debris samples yielded nine with some degree of infestation of the potato root eelworm, and all twelve yielded cereal root eelworm cysts. Detailed counts are given in Table 2. Checks for viability of the cysts were made on half the samples examined.

Table 2

Samples of Flotsam, Straw and Other Debris deposited at High-water Mark on Grassland

	Centre	Wt. of Sample Examined	Potato Eelworm Cysts	Cereal Eelworm Cysts
		grm.		
1.	Newsholme	36	6	10
2.	Bubwith	21	36	80
3.	Bubwith	27	2	3
4.	Escrick	23	3	8
5.	Howden—Barlby Road	27	22 (4 viable)	5 (1 viable)
6.	Howden—Barlby Road	24	0	2
7.	Kelfield (Wharfemouth)	28	19 (6 viable)	20 (4 viable)
8.	Kelfield (Marshes)	34	2 (1 viable)	3 (0 viable)
9.	Moreby	26	21 (7 viable)	36 (7 viable)
10.	Riccall	40	0	2
11.	Howden—Bubwith Road	23	0	3 (1 viable)
12.	Howden—Bubwith Road	30	1 (1 viable)	2 (0 viable)

TRENT AREA : DEBRIS. A farm, five miles north of the East Ferry infested area, was chosen for intensive sampling. It had been almost completely flooded, the water having passed over the infested land. Nine arable fields that had been under water were sampled (50 samples per 10 acres) and in none of these was eelworm found. Furthermore, potatoes grown on land that had been flooded were examined for the presence of potato root eelworm, but no cysts could be found on the growing crops.

Sampling was also carried out in the East Ferry area as the floods subsided. Samples were taken from

(1) arable fields—the newly deposited silt only being taken ;
(2) silt deposited on an inundated roadway ;
(3) flood rubbish (straw, dead leaves, plus silt, etc.) that accumulated at the edge of the flooded area, and where the roads rose out of the flood.

Samples taken from (1) and (2) gave no indication of eelworm. Samples from (3) however gave positive results. 25 grm. of the detritus from the roadway gave a count averaging three viable cysts and six non-viable. Flood rubbish taken from the side of rising ground in the same area gave a count of six viable cysts per 25 grm.

The sampling carried out in these areas suggests that the cysts liberated from the soil have been washed principally to the edges of the flooded area. Any deposition elsewhere on the flooded land contained so few cysts that they were not detected by normal sampling methods.

WITHAM AREA : RESAMPLING OF FIELDS. This area has been fairly well mapped for eelworm, the populations of many fields having been estimated. Consequently sampling after flooding of such fields could be expected to give information as to any spread that might have occurred.

Table 3 below gives the results of typical fields sampled before and after the flooding.

Table 3

BEFORE FLOODING		AFTER FLOODING, 1947	BEFORE FLOODING		AFTER FLOODING, 1947
Cysts per 25 grm.	Year of Sampling	Cysts per 25 grm.	Cysts per 25 grm.	Year of Sampling	Cysts per 25 grm.
15	1946	13	2	1946	1
8	1945	1	8	1946	5
21	1946	17	1	1946	0
8	1945	0	3	1946	2
10	1946	7	6	1946	3
10	1944	35	0	1946	1
9	1945	14	1	1944	1
4	1944	18	0	1945	1
43	1946	19	1	1946	1
27	1946	18	4	1946	4
0	1946	0	0	1946	1
7	1946	3	0	1946	0
3	1944	10	3	1946	2
5	1945	15	1	1944	0
0	1946	0	15	1943	3
10	1945	4			

Of six fields sampled and found to be free in 1946, on resampling after the floods, three are still free, and the other three show a trace.

Several fields showed appreciable rises in population, but upon investigation were found to have carried a potato crop since the previous sampling. Taking into account the normal drop in population from 1946 to 1947 despite the flooding, it would appear that such increases were due to reproduction as a result of the potato crop, rather than as a consequence of flooding.

WELLAND AND NENE AREAS: DEBRIS. A number of samples of straw and mud were collected from the high-water mark flotsam after the waters had subsided, and, after drying, were sifted and the finer materials examined, in 10-grm. samples, for the presence of eelworm cysts. Samples were examined from 18 sites. 11 out of 18 contained viable potato root eelworm cysts varying from 1 to 30 in 10-grm. samples. In addition, on seven of the eighteen sites, lemon-shaped cysts were found, with a maximum of two viable cysts per 10-grm. sample. Those could have been any of the beet, brassica, cereal or pea root eelworms, all of which have been recorded from the flooded areas. The most serious of these is the beet eelworm, on whose account many fields in the Eye-Newborough area are scheduled under the Sugar Beet Eelworm Order, 1942. The waters from these infested fields flowed over a considerable area in which the beet eelworm has not hitherto been recorded.

Previous Infestations in the Areas Studied

Eelworm surveys have been made in past years for advisory purposes in many of the parishes affected by the 1947 floods. An analysis of this survey showing the proportion of infested fields is given in Table 4.

Table 4

Eelworm Survey Cyst Counts

	Parishes	No. of Fields Examined	No. of Fields Infested with Potato Root Eelworm	
OUSE AREA				
	Cawood	95	76	
	Wistow	50	27	
	Hemingbrough	17	10	
	Kelfield	4	1	
	Barlby	11	7	
	Escrick	13	9	
	Riccall	2	2	
		192	132	Total
TRENT AREA				
	East Ferry	56	32	
	Greenhill Area	11	8	
	Laughton	6	6	
	Morton	11	6	
	East Stockwith	20	11	
	Butterwick	8	6	
		112	69	Total
WITHAM AREA				
	Nocton	118	92	
	Potterhanworth	33	23	
		151	115	Total

WELLAND AND NENE AREAS

Fields in the area affected by the floods which have been sampled during the winter of 1947-48 show a proportion of about 80 per cent with some degree of eelworm infestation. From previous experience this would seem to be about the same proportion as before the floods.

The proportion of infested fields to the number examined as shown in the above tables is very high and may not represent the true proportion of arable fields in the area infested by the eelworm because sampling was undertaken with the object of advising farmers on potato cropping. Some selection was exercised, therefore, and the fields examined were mainly on farms where eelworm trouble had been met with in the past.

When due allowance has been made for this, however, it is clear that the numbers of infested fields are still very great, so that if flooding can result in increased cyst distribution, conditions were very favourable for it to occur in the areas studied. There appears, however, to be little evidence that this has taken place.

Cysts may not be Spread extensively by Floods The number of viable cysts present in the flood samples was much lower than is normally encountered in field samples in the area concerned. This may be explained by the fact that counts are normally made from soil samples which have been air dried. In these circumstances the cysts readily float to the surface when the sample is shaken in water. When kept in water, however, they become waterlogged and sink. A laboratory test to determine this loss of buoyancy was made. Seven series of cysts collected from air-dried soil, 20 in each series, were set up in tubes in water. At the end of twenty-four hours 52 out of the original 140 cysts had sunk to the tube bottom and after another twenty-four hours a further 43 had sunk, and the remainder readily sank when disturbed. For this reason cyst counts for advisory purposes are made only from soil samples which have been air dried ; counts taken from wet soil are found to be unreliable.

A viability check on the cysts which sank showed that in every case the cysts which sank first were the cysts with the highest egg counts ; that is, the most recently formed cysts. The older cysts, partially empty of eggs, were the last to sink. From this it is to be expected that flood-borne cysts would be more likely to include those of low viability, rather than the newer cysts.

The areas under consideration had been waterlogged for some time before the floods occurred, owing to melting snow. It seems likely, therefore, that few, if any, of the cysts would float, and their buoyancy would be relative only to the silt and other matter carried by the river floods. It is unlikely that eelworm cysts would be carried for any distance, except in rapidly moving water.

Conclusions The investigations made indicate that as a result of the floods there has been no widespread heavy infestation with potato root eelworm cysts of land previously free from the pest.

There has been a spread in small numbers to new fields, but appreciable new infestation has been confined to flood margins. Moreover the cysts carried were mainly those of low viability.

There appears to be no evidence therefore that "Potato Sickness" has extended greatly as a result of the abnormal floods and, subject to good husbandry, the small degree of new infestation which has occurred need not be considered serious.

The same remarks apply to the other cyst-producing eelworms attacking beet, peas, brassicas and cereals.

As regards beet eelworm, even the slight spread of this pest may be more serious to the farmer because it is the subject of a control order. A measurable infection would at once render the field subject to this order. Farmers in such areas, therefore, should crop with caution during the next few years.

COLORADO BEETLE IN JERSEY, 1948

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AS a result of the drastic precautions taken in 1945 and 1946, it was hoped that Jersey would be almost, if not entirely, free from the Colorado beetle in 1947. Unfortunately, however, a heavy seaborne invasion from the Continent occurred on May 28, 1947, when many thousands of dead beetles were found on the seashore and hundreds of live ones on the potato crops. Altogether 70 areas, the majority of them small, were officially declared to be infested ; they were treated with carbon disulphide during the winter of 1947-48 and planted with a trap crop of potatoes in 1948. All these areas except one remained free from the pest in 1948, and in the affected area only one beetle was found. There is also evidence to suggest that a small outbreak of 5 beetles in 1948 was caused by hibernants from the previous year. Thus, despite the heavy and scattered invasion in 1947, Jersey would have been almost free from the beetle had not yet another serious incursion from the Continent occurred in May, 1948.

1948 Invasion The accidental discovery of a single live beetle under seaweed on a beach at the extreme north-east corner of the Island on Sunday, May 16, was the first sign of the invasion. Further search over this beach revealed 27 beetles, of which 9 were alive, with flying wings outstretched. A rapid examination of all the Island beaches on May 17 and 18 showed that a heavy invasion had occurred ; many thousands of live and dead beetles were found on the seaweed at the high-tide mark and some had begun to climb into the crevices of the sea walls and on to large rocks out of reach of the tides. The biggest numbers by far were at the north-east corner of the Island, and from here the infestation continued with diminishing intensity along the whole of the east coast and also along the north coast for a distance of about five miles. Beyond this continuous infested coastal strip many dead but comparatively few live beetles were found on the beaches. One interesting and practical point concerned with the invasion was that, occasionally, beetles submitted for examination and thought to be dead revived in the laboratory.

At invasion time the tides were springing and a strong north-east to east wind was blowing, causing huge breakers which probably pounded and killed many of the beetles on the shore. Another fortunate circumstance was that the weather remained cool and overcast for several days, which prevented the beetles from flying inland to the potato crops and allowed sufficient time for the beaches to be treated. On May 19 it was decided to spray with 5 per cent DDT dust the line of seaweed (where most of the beetles were) and as many of the infested sea walls and rocks as could be reached by the available spraying equipment. Special spraying gangs were delegated to do this work by Messrs Plant Protection Ltd., who, as in previous years, were the spraying contractors for the Committee of Agriculture of the States of Jersey. The first application was given before the seaweed was disturbed, and the second immediately after the seaweed had been gently turned over to expose the beetles sheltering beneath ; in some cases a third application was given. By May 23, when the spraying was completed, very few live beetles could be found on the beaches. The last live beetle was found on June 10.

Attention was next concentrated on the potato crops growing within a belt one mile wide along the east and north coasts. These received a special additional spray and were very carefully inspected. Meanwhile growers throughout the Island were urged to inspect their crops, and the usual spraying of the whole of the crops was being carried out.

Within a few days of the invasion the available evidence suggested that, in contrast with the 1947 invasion, few, if any, beetles had travelled inland and reached the potato crops, and this was confirmed as the season progressed.

Crop Infestation Throughout the whole season only 89 live beetles were found on the Island. Of these, 70 were discovered in late August on volunteer potatoes growing among a $\frac{1}{9}$-acre turnip crop; all the beetles had soft wing cases and white flying wings, which indicated that they had only recently emerged from pupae in the soil. The infested crop was heavily dusted twice with 5 per cent DDT, and the soil was injected with carbon disulphide in August and again in November. Of the remaining 19 beetles, 5 were single finds and the rest were found within small areas in three fields, two of which contained volunteer potatoes among the root crops.

The only other live beetles found in Jersey in 1948 were discovered on May 18 on a yacht in St. Helier harbour; the yacht had left Granville at 2.30 p.m. on that day, and on arrival in Jersey at 6 p.m. on the same day 1 beetle was found on deck and 1 on passenger luggage.

Conclusion During the past two seasons extensive and costly measures have had to be taken in Jersey, not to combat the few hibernating beetles persisting in the Island, but mainly as a precaution against the possibility of heavy incursions of beetles from overseas. A similar position will arise in 1949. For this and other reasons the Island is particularly interested in the setting up of an International Committee on the control of the Colorado beetle in Europe* and is anxious that success should attend the efforts to control the pest in severely infested countries and to prevent its spread to new areas.

Earlier articles dealing with the control of Colorado beetle in Jersey appeared in the January, 1947, and March, 1948, issues of *Agriculture*.

GRASS-FED BEEF

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EVERYONE is now talking about beef, and all farmers' discussions on the matter seem to lead to the conclusion that any additional beef we intend to produce will have to be grass-fed. The new schedule of feedingstuff prices, especially the new price for sugar beet pulp, gives no encouragement to the winter feeder. It seems, therefore, that it will be mainly by grass feeding that the calves now being reared under the calf subsidy will be finished for beef. Beef-producing methods begin with the production of the store cattle, and the day on which the grassfield gate is opened is the point at which the art of the grazier really begins This is one of the ancient skills of farming, the fine points of which have much to do with the ultimate financial result.

*WILKINS, V. E. International Scheme for the Control of the Colorado Beetle, *Agriculture* (October, 1948), 307.

Condition of Store Cattle The cattle that do best on grass in most circumstances are those that have been wintered outside on grassland, and have been fed with hay or other home-grown foods, so that they have kept their condition. They are already accustomed to grass as a food, so that they have none of the settling-down troubles to which yarded cattle are subject when first turned out. All winter they have had access to a little greenstuff containing vitamins and minerals, in contrast to the yarded stores which often go woefully short of both. There are fewer ranges of old pasture suitable for outwintering cattle than there were before the war. Store cattle wintered out on leys (and other grassland) are apt to jam up the turf and delay the start of the grazing season proper.

For these reasons most cattle intended for grazing have to be wintered in yards. If it is definitely the intention to finish them on grass they must be in fair condition when turned out, and the winter management must be arranged accordingly. In the North the foods will be roots, oat straw and hay; in the South more probably barley straw, hay, sugar beet pulp and a little meal. South-country roots and straw are not nutritious enough for cattle, and it will take half the summer, if not all of it, to make up the condition lost in the winter. There is, of course, something in the idea that store cattle, forward in condition and sleek in the coat, will suffer a setback on being turned out. Because that rather forced condition is the wrong condition to aim at, it does not follow that the stores should have "plenty of coat and bone" and not much else. Such bullocks might be the best bargain to *buy*, but their condition is not the one to be aimed at. There are always stories of animals "as poor as crows" being turned out and improving rapidly afterwards. "Dr. Green" is, of course, a wonderful healer. But in all such cases the bullocks have to restore their lost weight before they make any real gain. Grass-fed beef will not be a cheap commodity if it entails the see-saw process of making up the flesh lost in the winter.

Turning Out Turning out can be either gradual—for a few hours a day at first—or final and complete. More experienced people than myself have assured me that the gradual method is a mistake and that cattle once turned out will not be content to eat dry food inside. I have not found it so, provided the cattle are put out *early*—in April or March if there is any keep for them. In the south of England in May there is often a period of dull, very cold weather following rain. In such circumstances cattle newly turned out will scour and look utterly miserable.

Early turning out overcomes this trouble. Even a tiny quantity of protein- and vitamin-rich grass helps to improve the utilization of the roots and dry foods that still remain to be fed in the yards in the last month or so of sleeping in.

It is not always possible, of course, to arrange for cattle to be put out either gradually or early. Some of the best grazings are on marshes where flooding may not have cleared and where growth is always late. These fields are often a long way from the farm buildings.

The Grazing Plan The central problem of feeding cattle on grass is to make full allowance for the falling off in both the quality and the quantity of the grass in the late summer. No grazing plan is sound which is based on the principle of having a fixed head of cattle all summer on a fixed acreage of grass. Most graziers work on the principle of having two groups of cattle, one in more forward condition than the other.

The bigger, more forward cattle are bought late in the previous summer and are well wintered on the farm. They fatten on the first grass, and are gone by late June or early July. The second group is brought on to the grazing farms in spring. These cattle have the second quality pasture until the first group is cleared. Even though the bulk and quality of the grass has declined by that time, the cattle go ahead and do well when the rate of stocking of the land is reduced by about half. They will often make especially good progress in the autumn, when there is a final late growth of fresh grass. It should be possible to finish most of them on the grass. The rest will join the cattle for wintering and early spring feeding the following year. Many graziers also work sheep skilfully into the general plan, the better to control the amount of keep available at the time.

This plan may not be suitable for mixed farming conditions, but the principle of lifting the pressure of grazing in midsummer will have to be followed. One of the best methods of doing this is to transfer some of the younger cattle on to the aftermath of the hay fields.

Change is another essential of any good grazing plan, both for the good of the bullocks and of the pastures.

Old Pastures and Leys for Grazing Cattle The controversy over the relative merits of old pastures and leys is almost spent, but whichever of the two is used for fattening bullocks, it must be good. Farm sale particulars still advertise pastures "which will fatten without cake," though cake feeding on grass has become almost a thing of the past. The phrase is a reminder of the variations that occur in the feeding value of pastures. Heifers will fatten on grass not quite so good as that needed to "finish" steers.

Perhaps the ideal is to feed off the grass just as fast as it grows, and never faster. In practice it is very difficult to keep this balance, and the grass which accumulates in June is often very acceptable in late July. In other words, there has to be some form of cushioning. Leys tend to be less "resilient" in this respect than old pastures, and the grass of the flush period is not so acceptable after a month or two as the carry-over from the old grass. The art of using good leys to feed cattle is therefore more involved than grazing old pasture. Turning out early, using the mowing machine, and having different types of ley, are some of the devices of this art.

Such devices are also useful against the problem of "blowing". This is not the place to enter into any disquisition on the causes of this trouble, but it is generally agreed that it usually follows the grazing of damp, luscious grass and clover. The trouble seems more likely to occur on new grass than on old, and the policy, therefore, must be to graze the leys before they become too lush.

A supply of good water is, of course, a primary necessity, but there is another very elementary need which is often overlooked in ley farming—shelter. Cattle will not feed unless they are comfortable and they will not always be comfortable on an open arable field protected only by a wire fence.

The Age of Grazing Cattle Experienced graziers prefer cattle "with a bit of age about them". These cattle have finished growing as opposed to fattening, and their digestive system is probably better fitted to cope with quantities of easily fermentable grass. The grazier is concerned with buying the animals best suited to his job. It does not necessarily follow that it will pay a general farmer to run his stock to maturity before he attempts to fatten them. Getting that "bit of age" means repeated summerings and winterings and a slow turnover. It is often

1. Refuse deposited by floodwaters between Newborough and Eye.

Photo: *Mirror Features.*

2. Bank of flood refuse on grassland by the River Nene, near Sutton Bridge.

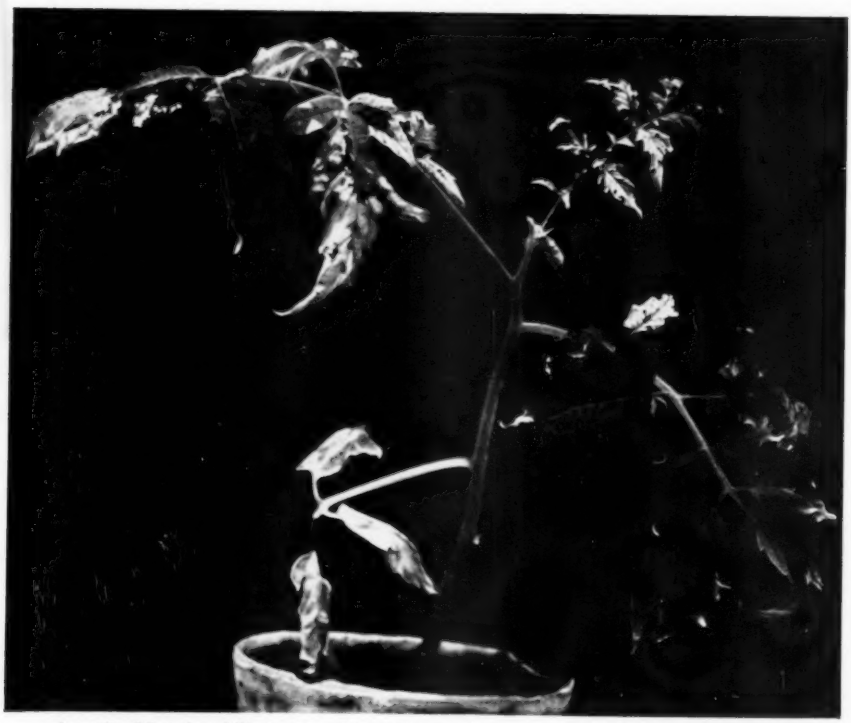
Photo: *R.A. Cooper.*

3. Potatoes from a clamp spread over the ground near the site of the Crowland breach, in the background.

4. All that remained of a potato clamp near Crowland after the water had subsided. Before the flood, soil from beneath a nearby clamp had given the highest eelworm count so far recorded in this area, cysts at riddling time being found still adhering to the potato tubers.

Photos: *J. O. Page.*

Tomato Spotted Wilt. The youngest leaves curl inwards and downwards; then small reddish circles and spots develop and coalesce, giving a characteristic metallic bronzing.



Aucuba Mosaic of Tomato. The yellow and green mottling is more pronounced than with Tomato Mosaic and may be quite brilliant.

Photos: *K. M. Smith.*

assumed that the cattle will grow on the by-products of arable farming. But where are the extra by-products to come from to feed an increased cattle population? In fact any increased numbers have got to be given foods—including ley grazings—especially grown for them. A balance must be struck over this age question. It is useless in present circumstances to try to feed cattle that are too young. On the other hand, it should be possible for cattle that have been reared well, and kept going steadily on suitable home-grown foods, to be sold fat off the grass at about three years old.

VIRUS DISEASES OF THE TOMATO

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LIKE the tobacco plant, the tomato is susceptible to infection by a very large number of viruses. Many of these viruses, however, are of academic interest only and do not infect the tomato under ordinary conditions of culture. These will not, therefore, be dealt with in this article, and attention will be confined to those which are, or may become, of economic importance. There are five viruses commonly associated with the tomato plant, of which only two, as far as we know, are insect-borne. In descending order of economic importance, these are the viruses of Tobacco Mosaic and its strains, Tomato Spotted Wilt, Cucumber Mosaic, Tomato Black Ring, and Tomato Bushy Stunt. The symptoms of these diseases and the methods of spread of the viruses will be described first ; next, two common potato viruses sometimes found infecting tomato plants will be dealt with briefly, and finally the methods of control will be treated collectively.

Tobacco (or Tomato) Mosaic One of the properties of viruses generally, which is also a characteristic of living things, is the power to change their form slightly, and plant viruses are no exception. A virus which shows this characteristic very strongly is that of Tobacco (or Tomato) Mosaic, which frequently infests tomatoes under glass. By special methods of selection it is possible to isolate an almost indefinite number of different strains, but in ordinary commercial tomato culture there are about four which commonly occur, and these only will be described.

The parent or type virus gives rise to the well-known Tomato Mosaic in which the leaves, especially the youngest ones, show a mottling of light and dark green. The fruit is normal in appearance. The reduction in yield of individual plants is not great, but in view of the widespread nature of the virus the total loss caused by it and by the next strain must be fairly substantial ; it has been calculated at about 8 per cent. *Aucuba*, or Yellow, Mosaic of tomato is so called because of a fancied resemblance to the variegated laurel (*Aucuba japonica*). It is similar to the Tomato Mosaic, but the mottling of yellow and green (p. iv of art inset) is more pronounced and may be quite brilliant, and the stunting effect on the plant is greater. The ripe fruit is frequently blotched and mottled with yellow.

A third strain of virus which is of much greater economic importance is "Stripe" or "Streak"—sometimes known as "Glasshouse" or "Single Virus" Streak to distinguish it from another Streak disease which is composite in nature and will be described later.

"Stripe" disease causes little or no mottling of the leaves but gives rise to large areas of dead cells (*necrosis*). The name "Stripe" arose originally because of a streak or stripe of dead cells running along the greater part of the stem length. The fruit shows brownish, sunken lesions or pits in the skin, and many of the leaves of an affected plant may die. Under certain conditions this virus may produce, instead of a severe necrotic disease, a mild mottling of the kind associated with the ordinary Mosaic type of virus. The exact reasons for this variation in symptoms are not known, but the variety of tomato plants affected and the degree of hardness of growth may play some part in determining Streak symptoms.

The last strain of Tomato Mosaic virus to be described is the Distorting, or Enation, virus. In severe forms of the disease due to this virus the lamina of the leaf is suppressed so that parts of the plant present a peculiar fern-like appearance. In some cases the undersides of the leaves may develop outgrowths ; these can be cup-like or in ridges, and are known as enations. Another symptom is the occurrence of large numbers of small leaves ending in a corkscrew tendril.

The method of spread of the Tomato Mosaic virus and its strains is the same in each case. As far as we know, insects play no part in their transmission. These viruses are intensely infectious and are spread mainly by mechanical contact between healthy and diseased plants and by contamination of workers' hands and implements. The question of the transmission by seed is a vexed one ; it is possible that the virus is occasionally spread in this manner, but it cannot occur very often.

Tomato Spotted Wilt This virus disease was described for the first time in Australia in 1915 and was first recorded in Britain in 1932. Since then it has spread all over the British Isles and Europe and is probably to be found wherever the tomato plant is grown. It is now one of the most important diseases of the indoor tomato crop, though not so widespread as Tomato Mosaic.

The disease develops about 10–14 days after infection, the first sign being a curling inwards and downwards of the youngest leaves ; then small reddish circles and spots develop and coalesce, giving a characteristic metallic bronzing. If the temperature is high the bronzing rapidly dries out and the leaves die. This stage of the disease is the most dangerous to young plants and recovery is infrequent. In older plants the bronzing stage is followed by a yellowish mosaic mottle on the leaves, which are often distorted. The fruits are poor in quality and frequently show concentric yellow or brown rings.

Tomato Spotted Wilt virus is carried by a thrips. It is the only plant virus known to be spread by this type of insect, and it cannot be transmitted by any other insect species. There is no evidence of seed transmission.

Cucumber Mosaic Virus From being the cause of a mosaic disease mainly on cucumbers, this aphis-transmitted virus has now spread to a very wide range of perennial flowering plants such as dahlias, delphiniums, and chrysanthemums. In consequence, there is nearly always a source of virus in the vicinity of cucumbers and tomatoes, and the chief reason why tomatoes are not more frequently infected with this virus is probably that the plant, except in its younger stages, is not a

favourite host plant of the aphis vector of the virus. Symptoms of this virus on tomatoes take the form of a narrowing of the leaf blades, though the very extreme form of "fern leaf" symptom is not common in this country ; there is usually also a faint mottling of the leaves. This disease is not usually of much importance in the glasshouse but sometimes causes serious losses in tomatoes grown out-of-doors.

Tomato Black Ring This is a comparatively new disease and was described for the first time in 1944 ; in some ways the symptoms resemble those of Spotted Wilt but the two diseases can be differentiated. The first sign of infection is the appearance of numerous small black rings on the leaves, but there is none of the metallic bronzing which is usually present with Spotted Wilt. The rings spread and coalesce, killing out the growing point, and young tomato plants are often killed by a general necrosis.

Tomato Black Ring is a serious disease, as far as young plants are concerned, but if they survive the initial stage they grow away from the necrotic symptoms and show only faint concentric rings on the leaves. Like the viruses of Cucumber Mosaic and Spotted Wilt, this virus attacks a great many different plants, a large number of which show no symptoms. The method of spread of the Black Ring virus is not known ; it does not appear to be carried by any of the common insects associated with the tomato plant. In this country the disease seems to be confined to East Anglia, but a similar disease has recently been recorded in India.

Tomato Bushy Stunt This virus disease was first recorded in 1935 on some tomato plants from the west of England, and subsequently in one or two other centres. Since that time it has appeared only once, but it is mentioned here because of its great scientific interest and because it may turn up again at any time and cause losses to tomato growers.

Like the Black Ring disease, Tomato Bushy Stunt is most severe on the young plants. The first sign of infection is a slight yellow mottling of the young leaves, and the upward growth of the plant ceases. Frequently the affected plants fall over, owing to the development of a necrotic lesion at, or about, soil level. There is a tendency for the leaves to show a yellowish or purplish colouring with some ring formation. Older plants may be bushy and stunted because of the development of lateral growth. There is no information on the method of natural spread of this virus.

Double (or Mixed) Virus Streak This disease arises when tomato plants already infected with Tomato Mosaic also become infected with the Potato Mottle virus, known as Potato Virus X. Double Virus Streak is an important disease in the U.S.A., where tomatoes and potatoes are grown in close proximity, but in Britain it does not often occur since tomatoes are largely a glasshouse crop. Because Potato Virus X spreads, as far as we know, only by mechanical contact between diseased and healthy plants, there is very little opportunity for the potato virus to infect tomatoes, though the virus might be carried to tomatoes on the hands of workers who had recently handled potato plants. When it does occur this type of Streak is similar to the Single Virus Streak but may be rather more severe. The first sign of infection is the appearance of numerous dark spots or lesions on the top leaves, and similar longitudinal lesions or streaks develop on the petioles and stem. If the growing point is not killed, the plant may survive, but it remains stunted, spindly, and unthrifty. The fruit is usually marked with irregular sunken patches.

One other potato virus is occasionally found infecting tomato plants, especially those grown out-of-doors. This is an aphis-transmitted virus known as Potato Virus Y, and the disease caused in the tomato plant is very mild. Leaves of affected plants show a faint mottling caused by a banding of the veins with a deeper green colour. The symptoms are never strongly marked, and as the plant grows they may disappear altogether.

Control of Tomato Virus Diseases Some of the virus diseases of tomatoes described in this article are most common in mixed houses where ornamental plants are grown near the tomatoes. This applies especially to the Spotted Wilt and Cucumber Mosaic viruses. As far as Spotted Wilt virus is concerned, arum lilies, chrysanthemums, and dahlias are frequently infected, whilst chrysanthemums, dahlias and delphiniums commonly harbour the Cucumber Mosaic virus. It is sometimes difficult to tell from inspection alone whether some of these ornamental plants are actually infected, since symptoms may be very mild and transient. Wherever possible, therefore, tomatoes should not be grown in the same house as ornamental plants.

It should be remembered, also, that the Spotted Wilt and Cucumber Mosaic viruses are insect-borne and that they will not spread in the absence of their respective vectors—the thrips for Spotted Wilt and the aphis for Cucumber Mosaic. Both these insects can be kept under control by regular nicotine fumigation.

Viruses of the Tomato Mosaic type are not insect-transmitted, and control measures are therefore rather different. The first and most important measure is to eliminate the sources of the Mosaic infection, which may be : (1) the seed, (2) cigarettes and pipe tobacco, or (3) portions of diseased plants left in the soil from the previous year.

It has already been pointed out that the question of seed transmission of Tomato Mosaic has not been answered satisfactorily. To be on the safe side, therefore, it is always better to save seed from Mosaic-free plants. In potting the young tomato plants it is very important to be on the look-out for any suspicious mottling of the leaves ; plants showing these symptoms should be destroyed and their near neighbours put on one side for re-examination in about two weeks' time. Since this type of virus is so infectious, one or two plants with Mosaic are sufficient to infect a house of several thousand because the infection is carried over from plant to plant during routine cultural operations.

The Tomato Mosaic virus is very stable and heat-resistant, and consequently is usually present in an infectious state in cigarettes and pipe tobacco. It is undesirable, therefore, to smoke whilst handling tomato plants, and the hands should be washed frequently with soap and water. Because this virus is so stable and resistant, it will remain infectious in pieces of plant tissue for long periods, and may even persist from one season to the next. Whilst this is not considered a very important source of infection, it is one which should be borne in mind.

Correction

Yarded Beef Production (May, 1949), p. 77, para. 1, line 8.
For "£45" read "£15".

CLAY MARLING: MECHANIZED METHODS

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and
A. C. MIDDLETON, B.Sc. (AGRIC.), Q.A.L.A.S., *Surrey Agricultural Executive Committee*

WHEN the East Riding War Agricultural Executive Committee was considering means of increasing the output of the arable land in the Riding, they believed that a revival of clay marling could be of considerable assistance on some of the sand farms*. It was clear that an alternative to the cheap and plentiful supply of labour which had been used for the work in the past would have to be devised and, in the spring of 1944, discussions with the Ministry of Agriculture were concluded whereby the East Riding Committee was asked to conduct an investigation into the costs and organization of mechanized methods of clay marling. Arrangements were made for the work to begin in September, 1944, and conclude in September, 1946. Some of the work was carried out directly by the Committee and some on their behalf by public works contractors.

Blowing on Sand Lands of the East Riding

There is a considerable area of light sand land in the East Riding, of which about 40,000 acres would benefit from clay marling. The sands are in two main areas—one in the Vale of York, and the other in the Vale of Pickering. They lie immediately to the south-west and to the north of the great crescent of chalkland which is the Yorkshire Wolds. Between the sands and the Wolds there are deposits of Speeton, Lias and Keuper clays, which, in earlier days, were dug out and spread on the light blowing sands. Latterly, the practice died out, owing to the rising costs of labour.

When there is a high wind, many of the unmarled sands blow so easily that crops in the seedling stage may be torn from the soil or so severely damaged that resowing is necessary. Inevitably, costs of production are increased and yields are reduced through late development, the significance of which needs no emphasis when those crops are, in the main, sugar beet and carrots. Further, ditches very soon become choked with blown sand. The prevention of blowing is not the only benefit to be derived from marling; the soil texture is improved, and a wider range of crops can be grown.

In addition to the condition of the surface soil, other important factors affecting blowing are the contour of the land, the presence or absence of shelter belts, woods and field hedges, the types of cultivation and the relationship between prevailing winds and the season of the year. Often only parts of a field blow badly, e.g., the tops of small undulations in an otherwise comparatively flat field, and of the 1,662 acres marled during the investigation, 46.9 per cent comprised small parcels of land of less than 5 acres, and a further 29.1 per cent were fields or parts of fields of between 5 and 10 acres.

In planning the mechanical equipment for the investigation, it was clearly necessary to decide a suitable rate of application of the marl. Comparison of a good carrot-growing soil with one of the blowing sands suggested 80-100 tons per acre. After inspecting fields dressed at this rate, growers considered the quantity insufficient, and the rate of application was raised to 150 tons per acre. Dressings above or below this quantity could be applied at the special request of the person for whom the work was being done. By the time the investigation was completed, 248,221 tons of marl had been

* MIDDLETON, A. C. Clay Marling: Some Historical Notes. *Agriculture* (May, 1949), 80

applied to 1,662 acres at an average rate of 149.3 tons per acre. Much more information is required about the effects of different rates of application, and so trials were laid down in the county with rates varying from 50 to 200 tons per acre.

The complete job of clay marling may be divided into three main sections: (a) selection and operation of the pit ; (b) transporting the marl from the pit to the field ; (c) spreading the marl on the land.

Pit Operation It is clear that a pit should be opened only where there is an adequate supply of clay either at or very near the surface. A well-sited pit should involve the minimum removal of overburden, provide an adequate quantity of marl, be free from serious flooding and so placed that there is short and good access to a hard road, preferably downhill, to facilitate the departure of laden transport. When the site has been determined, negotiations must be completed with owners and occupiers for rights of way to the land which is to be marled. Moreover, if new pits are opened, the effect of the Town and Country Planning Act, 1947, should be considered in relation to possible development charges where the marl is to be sold for use on land not "held with" the site of the pit, and in relation to the general planning regulations.

In some of the twenty-nine pits opened, flooding was a serious menace and pumping became necessary. Careful excavation can help to overcome the difficulty by leaving barriers of clay in the form of bulkheads to confine the water. If the marl is excavated in a dry, friable condition, it is much easier to spread in the field.

At first, when very wet weather was experienced, an attempt was made to keep the work going whatever the conditions. This soon proved to be faulty practice and, subsequently, operations were stopped as soon as the weather worsened. It was found that, by so doing, work could be re-started with the least delay.

The laying of chestnut pale and sleeper tracks can improve access to and departure from the pit and thus avoid many delays due to rutted roads. An observant and conscientious pit foreman can foresee trouble and avoid delays.

DRAG-LINE AND FACE-SHOVEL In all but one of the pits excavation was from land level downwards, for which drag-line excavators were employed. A 32-feet jib on the drag-lines was generally satisfactory to deal with the depth of clay available and, working with a 12-cu. feet bucket in favourable conditions, a day's output was 250-275 tons per machine. 300 tons per day was often exceeded, and the record daily output was 485 tons.

In one exceptionally good pit, at West Heslerton, where the overburden was negligible and the clay was over 40 feet deep, terrace working was possible and allowed two drag-line excavators to work simultaneously at different levels. For safety reasons two machines should not work one immediately above the other. Although 28,000 tons of marl were obtained from this pit, there was the minimum loss of land and spoliation of the country.

At one pit, at Hotham, the clay outcropped on a fairly steep hillside and a face-shovel excavator could be used. Its output compared favourably with that of the drag-lines. The difficulty of wet clay adhering to the buckets was overcome by fitting hardwood linings, and it was necessary to elongate the catch on the release gear of the face-shovel, which otherwise became choked with clay.

MULTI-BUCKET EXCAVATOR It was hoped also to investigate the operation of a multi-bucket excavator but, owing to difficulties of delivery in 1945 and the early part of 1946, only a few days' work was obtained. This was unfortunate, because experience of the machine in brickyards suggested that it would be useful in clay marling, provided the deposit gave the equipment adequate scope.

SCRAPERS, CABLE-DRAG SCRAPERS, SLURRY MILLS Scrapers now used on opencast coal sites, aerodrome construction and other large earth-moving contracts, were not employed: first, because of the difficulty of delivery at that time; second, because their size would introduce great difficulties in travelling on farm roads; and third, because they could not deposit the marl in a carpet less than 2 inches thick. Such a dressing would be equivalent to a rate of approximately 330 tons per acre, or more than double the usual application.

Excavation with cable-drag scrapers was also considered, but they were not employed as their use is limited to operations where the pit is in the field to be marled, and these circumstances rarely occurred during the investigation.

The possibility of emulsifying the clay in a slurry mill and pumping it on to the land was also reviewed, but this is not possible where the marl is to be transported any distance. Furthermore, adequate water supplies were not available, and the stones which occur in so many of the East Riding marls would have interfered seriously with the process.

Transport:
TRACTOR-TRAILERS Where the pit is only a few hundred yards from the land which is to be marled, the usual type of agricultural tractor and trailer may be used for transport, especially if the farmer is to carry out the work during slack times. They are not suitable for large-scale operations where the marl has to be carried and then dumped in small heaps preparatory to spreading. A sticky clay cannot be spread from a trailer with the same facility as, say, farmyard manure. Moreover, a "train" of more than one trailer is unwieldy to handle.

"DOBBIN" WAGONS In 1944, when tipping-lorries were very scarce, it was decided to use tractors and "Dobbin" wagons for transport purposes. The "Dobbin" wagon consists of a side-tipping tub and chassis mounted on two pneumatic-tyred wheels. It can be drawn singly or coupled in trains of two or more. They carried a larger load than farm trailers, 30-35 cwt. each, or 4½ tons in a train of three hauled by a single tractor. Industrial tractors were chosen instead of agricultural tractors to haul the wagons, because of their higher road speeds. Where, however, travel is wholly or mainly on farm roads or tracks, any of the usual agricultural tractors could be used and, of course, since 1944 there have been many developments in tractor design to give higher road speeds.

TIPPING LORRIES Later, in view of the restrictions imposed by the Road Traffic Act, 1930, upon the haulage of laden trailers and their effect on contracts involving road travel, the "Dobbin" wagon organization was replaced by 3-, 4- and 5-ton tipping lorries. Their operating costs were higher than those of the tractor-"Dobbin" trains.

DUMPERS On a few contracts, dumpers were engaged as part of the transport service. Although the most modern design allows them to be used on the highway and they can carry 1-4 tons of material, it appears that for marling they are best suited to work near the pit. The maximum distance appears to be ¼-½ mile. They achieved high speeds under load, but

a weakness which they share with the tipping lorries is that the load of marl is dumped in a single large heap, up to 4 tons in weight, compared with the larger number of small heaps, of, say, 1½ tons each, when the side-tipping "Dobbins" are used.

The choice of route from pit to field demands the most careful consideration, taking full account of the type of vehicle, its weight laden and the travelling conditions. It may, of course, require revision according to changes in the weather during the progress of the work, and the shortest cross-country route is not always the quickest.

Spreading Marl in the Field Spreading the marl on the land presents greater problems than either excavation or transport, because not only must the work be carried out at a reasonable cost, but the clay must be left in a state in which it may become incorporated uniformly with the soil. A friable marl such as Keuper is easier to handle and spread than a tenacious Speeton clay, and, with the latter, weathering on the field before spreading can be of considerable help.

The marl was dumped from the "Dobbin" wagons so that an area of land having a radius of not more than 10-12 feet could be dealt with from each heap. Two men were enough to spread such a heap; if more men were employed they tended to get in each other's way. In very favourable circumstances eight good men could spread 200 tons in an eight-hour day; that is, an average of 3⅛ tons per man per hour, but the average output for all manual spreading was not more than about 1¼-1½ tons per man per hour. At first, Italian prisoners of war and later Germans were employed, but however carefully the work was planned, it proved to be very monotonous.

By Machine Various combinations of tractor, cultivator and tool-bar equipment were tried to replace hand labour, but none proved really satisfactory, nor were ordinary angledozers and bulldozers any more successful, as the tracks tended to squash the clay into the surface soil. Little more success attended these methods when the marl was to be spread on a hay or corn stubble rather than broken land, and it was clear that some newly designed equipment would be necessary if spreading were to be carried out efficiently and to the required standard.

In 1945 one of the contractors introduced an Austin-Weston Grader, an elaborate machine of American manufacture. Its chief virtues were its hydraulically-operated angledozer blade and its ability to straddle the marl heaps, which could then be split and spread. Although the machine performed satisfactory work, operating costs were comparatively high and it is unlikely that it would be suitable for the future, except on very extensive operations.

It was found that transport and spreading accounted for about three-quarters of the cost of the complete operation. If a transport unit could be fitted with a spreading mechanism, a considerable saving would be made. To this end the Howard-Fowler Marl-Clay Spreader was devised. This is tractor-towed and consists of a steel container of 5-ton capacity mounted on the back axle and rear wheels assembly of a rubber-tyred tractor. 1½-inch angle-iron slats, spaced 12-14 inches apart upon two parallel endless chains, move from the front to the rear along the bottom of the hopper-shaped container. At the rear there is a slatted gate oscillating vertically to control the passage of the marl on to fast-revolving blades which disintegrate the clay and spread it evenly over the land. The spreading mechanism is driven from the power take-off of the towing tractor and, if necessary, the back axle of the latter can be connected to the axle of the spreader, thus converting the outfit into a four-wheel drive vehicle.

The machine was designed to apply 75 tons or 150 tons per acre, although sprockets could be fitted to give intermediate rates. It was found preferable to give two applications at 75 tons per acre, rather than a single dressing of 150 tons per acre.

The general performance was very satisfactory and, altogether, proved most promising.

Costs and Methods Compared The investigation has shown that clay marling can be undertaken satisfactorily with mechanized equipment. The economic aspects are a matter for each individual owner or occupier, according to his particular circumstances. The varying costs and man-power requirements of the methods used during the investigation are summarized in the following Table. They are calculated from the actual working records and thus reflect the wage rates and costs of mechanical maintenance and operation ruling from September, 1944, to October, 1946. Italian and German prisoner of war labour and male and female civilian labour were employed for varying periods.

Analysed Costs of Each Operation in Pence per Ton (in bold type) and in Man-hours per Ton (in italics)

	Committee			Contractor A	Contractor C	Contractor C
EXCAVATION:	**7.0** *0.07*	**7.0** *0.07*	**7.0** *0.07*	**13.5** *0.06*	**11 5** *0.06*	**11.5** *0.06*
TRANSPORT:						
Tractors/Dobbins	**10.1** *0.43*					
3-ton Tippers		**25.4** *0.38*				
4-ton Tippers					**12.9** *0.12*	
5-ton Tippers				**13.2** *0.13*		
SPREADING:						
By hand	**15.3** *0.75*	**15.3** *0.75*			**14.2** *0.69*	
Grader				**12.1** *0.03*		
Marl-Spreader			**31.3** *0.72*			**4.8** 0.07
Total Cost	**32.4**	**47.7**	**38.3**	**38.8**	**38.6**	**16.3**
Total Man-hours	*1.25*	*1.20*	*0.79*	*0.22*	*0.87*	*0.13*

The time taken for excavation remained fairly constant throughout the investigation, and the cost of 11½d. to 1s. 1½d. a ton incurred by the contractors is a better figure to take than the 7d. per ton cost to the Committee. The low wage rates for prisoner of war labour in 1944 and 1945 affected the latter figure.

Tractors and "Dobbins" provided a cheap and satisfactory means of transport within their strictly limited use, and compared favourably with the cost of the tipping-lorries operated by the contractors. The high cost of running the Committee's 3-ton tippers was due very largely to difficulties encountered in having to engage unskilled drivers—a complication that did not beset the contractors.

Mechanical spreading reduced the man-hour requirements, but with the Austin-Weston Grader the cost remained about the same, owing to high overhead charges. The combination of transport and spreading with the Howard-Fowler Marl-Clay Spreader reduced both cost and man-power and, whilst the charge of 31.3d. per ton is unduly high (it included all the development work with the prototype), the cost of 4.8d. per ton is lower than would normally be expected and was achieved on a small and very favourably situated contract.

The varying labour and machinery requirements of the component operations of excavation, transport and spreading have had a compensating effect on one another, so that the total cost of each method shows only slight variation from 32.4d. to 38.8d. per ton. This comparison excludes the cost of 47.7d. per ton, which was unduly high owing to the exceptional transport costs already mentioned, and the 16.3d. per ton, which was exceptionally low because of the very favourable operating conditions.

Charges to Participants in the Scheme The seventy-seven participants in the scheme, for whom 108 contracts were completed, shared the total cost of the work in each year on the basis of a "pool price" per ton of marl, which was subject to a Treasury contribution towards the cost of the investigation. In the first year, the pool price was 2s. 8¼d. per ton, and in the second year 3s. 9½d. per ton. Thus, at 150 tons per acre, the gross cost was £20 3s. 1½d. per acre in the first year and £28 8s. 9d. per acre in the second year. Where the marl was purchased from one landowner for application to the land of another, the actual cost was charged in addition to the pool price.

The Future It is considered that any future large-scale contract operations should be confined to the most favourable eight or nine months of the year, and, by making full use of combined transport and spreading equipment, it is probable that the total cost would be between 2s. and 3s. per ton or approximately £15 to £20 per acre at 150-ton rate of application. This assessment is based on the wage rates and costs of mechanical operation last autumn.

It should be emphasized that this investigation was confined to the East Riding of Yorkshire and that conditions in other counties may well need other methods and modifications in the types of equipment. There is no doubt, however, that the age-old practice of clay marling can be performed efficiently with modern mechanical equipment, and it is also certain that this method of land improvement has a part to play in increasing the productivity of many of our light sandy soils.

FARMING AFFAIRS

Milk Production in Cornwall, Devon and Dorset

The statement that investigations into the economics of milk production are dangerous because they direct attention to only one aspect of mixed farming economy, if valid in some areas, scarcely applies to the investigation which has resulted in Farmers' Report No. 55, published by the Department of Economics, University of Bristol. The report analyses the costs, returns and margins of 74 milk production enterprises in parts of Cornwall, Devon and Dorset. The danger must be the difficulty of securing in such a relatively small number of holdings a truly representative cross-section of the very large number of farms (8,000 in Cornwall alone) on which milk is a major source of income.

In such a case statistical results tend to be influenced by exceptional circumstances, like the 3 out of 10 north Dorset herds in which above-average efficiency has helped to make the margin per cow £11 higher than in the west Cornwall group. Lest the latter takes excessive comfort from this, let it be said that producers who lend their businesses to such surveys tend to be those who at least strive for efficiency to the best of their ability in the conditions under which they farm. Nor is there much comfort for those of us who may still cherish an ambition to set up in business. The capital investment on stock and purely dairy equipment, excluding of course the general farm equipment, is high.

According to this report, which covers the 1947-48 milk production year (incidentally an exceptionally favourable one), feedingstuffs produced on the farms accounted for 25 per cent of the gross cost of the milk. This emphasizes the wisdom of the decision to extend the survey to cover such costs, and the importance of advisory officers interesting themselves in farm planning so that through maximum production the minimum area can serve this need.

The report confirms trends which the interested observer of milk production from the outside would expect to see :

(a) Yield per cow has increased mainly in herds in the lower yield groups. It was, however, a favourable year.
(b) As a result the cost per gallon was lower than in 1946–47, although the cost per cow was slightly higher.
(c) Herds averaging over 800 gallons were nearly four times as profitable, at £47 8s. per cow, as those averaging less than 500 gallons. There are 7 herds in the former group and 12, including 2 giving less than 400 gallons, in the latter.
(d) Herds producing graded (T.T.) milk were more profitable than those producing non-graded milk—presumably a measure of greater interest, and, therefore, efficiency.

The farmer can gain much from an intelligent study of this report. The advisory officer can gain more and is in a position to pass the lessons on to, at any rate, a proportion of the many who produce milk in these parts of the South West Province.

Keeping Farm Machines in Good Condition

"If starvation is avoided over vast areas of the world, it will be due largely to modern farm machines in the hands of capable farmers." So say the authors, Arthur W. Turner and Elmer J. Johnson in the Preface to their recent *Machines for the Farm, Ranch, and Plantation*,* a book designed to promote the efficiency of all kinds of farm machines by a basic understanding of the needs of maintenance and thorough servicing. Ever since the marriage of implement to power, with the harnessing of the first ox to the wooden plough, farm productivity has gone steadily forward, always bringing with it new problems for the farmer, the farm engineer and

*McGraw-Hill 36s.

the economist to solve. The degree of mechanization depends, of course, on the size and nature of the farm, the capital available and the economic return which it is estimated can be secured, and every farmer will weigh these cardinal factors carefully before translating his cash into fixed capital. But having taken the plunge, it is in his own interests, no less than in the interests of the world need for more food, that the efficiency of his small tractor, windrower or combine harvester, as the case may be, should not be impaired by neglect.

Although addressed to the American farmer, this profusely illustrated book would be a valuable adjunct and another farming "tool" to farmers, farm students and advisers in this country.

Rations for Livestock Apart from the addition of the extended and bonus schemes for pigs and poultry and a variation in the farrowing sow allowance, the ration scales for livestock which came into force on May 1 are the same as those for last summer. However, the farrowing sow allowance will be increased on July 1, and rations for pigs will be increased on September 1.

PIGS AND POULTRY. Basic rations for pigs and poultry will be provided at the summer scale of 1 cwt. per pig and 1½ cwt. per 20 poultry for each month up to and including August, in respect of one-fifth of the numbers registered as being kept on the holding in 1939 or 1940, less a deduction at the rate of 1 pig for every 64 acres and 3 birds for every 16 acres of the holding. Allowances for sound poultry breeding stock (based on the autumn, 1948, count) and for pedigree pigs, additional to basic rations, also remain unchanged. The arrangements made under the new extended scheme for pigs and poultry, which was introduced last October and reopened recently to new applicants, will continue. The higher summer rate of rations for poultry under this scheme is dependent on an increase of at least 50 per cent of birds over the specified winter numbers.

On September 1 basic rations for pigs will be increased by about one-eighth, subject to the full number of pigs for which rations are issued being kept. Holders of combined registrations for pigs and poultry will benefit on the understanding that increased numbers of pigs are kept. Under the extended scheme, there will on the same date be an increase in specified numbers of pigs, related to the size of the holding, of approximately 50 per cent with a modification of the present limitation on the issue of rations for sows. Those who wish to transfer from the basic to the extended scheme will be able to do so before September 1.

FARROWING SOW ALLOWANCES. The allowances for farrowing sows and gilts are now at a standard rate of 8 cwt. The rate will be increased to 9 cwt. on July 1. C.A.E.C.s have discretion to grant farrowing allowances to applicants whose holdings *exceed* 1 *acre* who do not normally draw rations for pigs. The Committee must be satisfied that the pig-keeper has facilities for successfully breeding pigs and the means of providing food for the sow between farrowings. And the number of farrowing allowances will not exceed those which would be applicable under the new extended scheme.

BONUS RATIONS are available (on application to the C.A.E.C.) based on pigmeat or eggs sold through approved channels to the Ministry of Food during the period January to April. The bonus rates will be 1 cwt. per 8 score (160 lb.) of pigmeat delivered during the four months January to April and 1 cwt. per 160 dozen gradable hen and duck eggs delivered to a packing station during the 17 weeks ended on April 27, 1949.

From September 1 the bonus ration for pigs will be 3 cwt. per 160 lb. of pigmeat delivered during the previous four months.

COWS AND CALVES. Rations on the same scale as last summer are now available, on application to County Agricultural Executive Committees, for dairy herds with relatively high average yields, and for calves under 6 months old. Supplementary allowances may again be made if poor growth of grass is affecting milk output, or for individual high yielding cows in herds with an average yield too low to qualify for rations, or for dry cows and calving heifers requiring some concentrates before calving. A separate announcement will be made later about rations for cows and heifers calving in the autumn.

OTHER ANIMALS. Allowances for horses, goats and other animals will be obtainable on application under conditions similar to those in operation last summer.

SALES OF SEED OATS, SEED BEANS AND SEED PEAS OF FEEDING VARIETIES Arrangements are again being made, as last year, for feedingstuffs coupons to be supplied, on application, to growers of oats and of beans and peas of feeding varieties from the 1949 harvest who, by selling these crops for seed, have left themselves short of feedingstuffs for the livestock on their holdings. The arrangements do not apply to beans and peas of varieties grown for human consumption or to oats, beans and peas sold for feeding or milling purposes.

Applications for coupons under these arrangements must be accompanied by a certificate from the buyer that the seed crops have been delivered after July 31, 1949, and should be made before May 31, 1950, to the County Agricultural Executive Committees in England and Wales.

Nature Month by Month: June In "leafy June" natural life reaches its zenith. The trees of the wood are full-foliaged; the hedges gay with dog-roses; the lanes with campion, red and white, and here and there some late bluebells. In the meadows there are celandine and speedwell, daisies and many other flowers, and by the river the massed gold of the kingcups seems to blaze in the summer sun.

Among the limes the drone of innumerable insects is like a sustained organ note, and every bush and yard of turf has its teeming insect life. In a ride in the wood a party of black and orange sexton-beetles are busily interring a dead shrew. The sandy waste beyond the wood has many fast-moving tiger-beetles, quartering the ground in search of prey, now and then taking wing, green as emeralds.

The young thrushes of the first brood have flown, and many of the parent birds are occupied with second families. Even the latest arriving migrants are nesting now. On a thorn bush a butcher-bird's "larder" is mercilessly displayed. Perched on a post in the garden is a trim spotted flycatcher; now and then it darts out in pursuit of some winged insect and returns quickly to its look-out. In a clearing of the wood there lie, like two carelessly thrown pebbles, the eggs of a nightjar.

Following a heavy rain and a spate some early peal are up. They will not move much by day, but in late evening or after dark they may rise to a fly or be lured by a spinning minnow. Some half dozen of them lie in the tail of a pool; one of them turns lazily with a flash of silvery flank. A cock dipper bobs and bows from a boulder in midstream, his white bib conspicuous against the sombre shades of the rest of his plumage.

The Moor is drier, now, although some of the mires need care in circumventing. There is one I know that has across it a curiously directed, submerged granite pathway. As a small boy I was shown the trick of it—five

yards half-right, ten straight ahead, three half-right again and then another three half-left. A careless foot on either side at any stage of the journey, and one is in a mess.

Summer is here and the sun rides high. At noon, one is grateful for a little shade. Soon the longest day will have come and gone, and the evenings will be drawing in again. *F.H.L.*

AGRICULTURAL STATISTICS ENGLAND AND WALES

June 4, 1948, Agricultural Returns (Final Results)

CROPS AND GRASS

(thousand acres)

DESCRIPTION	*1939*	*1947*	*1948*
Wheat	1,683	2,075	2,188
Barley	910	1,879	1,897
Oats	1,358	1,963	1,992
Mixed Corn	83	489	588
Rye, for threshing	(c)	32	57
Rye, for green fodder	(c)	4	5
Total Rye	**16**	**35**	**62**
Beans, for stock feeding	133	81	80
Peas, for stock feeding	37	36	45
Potatoes, first earlies	56	167	222
Potatoes, main crop and second earlies	398	774	895
Total Potatoes	**454**	**941**	**1,117**
Turnips and Swedes for stock feeding	396(d)	401	355
Mangolds	210	264	272
Sugar Beet	337	386	405
Rape	53	115	104
Cabbage, Kale, Savoys and Kohlrabi, for stock feeding	94	165	189
Vetches	49	27	38
Lucerne	32	(e)	(e)
Mustard, for seed	24	36	17
Mustard, for fodder or ploughing in	24	25	21
Flax, for linseed	4	52	86
Flax, for fibre			14
Hops	19	22	23
Orchards with crops, fallow, or grass below the trees	236	260	255
Orchards with small fruit below the trees	18	11	12
Small fruit, not under orchard trees	29	25	28
Vegetables for human consumption (excluding potatoes), Crops under glass, and Flowers	275	554	583
All other crops	32	50	45
Bare fallow	355	497	238
TOTAL OF CROPS AND FALLOW (TILLAGE)	**6,862**	**10,388**	**10,652**
Clover, Sainfoin and Temporary Grasses for mowing	1,304	2,273	2,079
Clover, Sainfoin and Temporary Grasses for grazing	768	1,331	1,378
Total Temporary Grass	**2,072**	**3,604**	**3,457**
TOTAL ARABLE LAND	**8,935**	**13,992**	**14,109**
Permanent Grass for mowing	4,612	2,597	2,655
Permanent Grass for grazing	11,097	7,651	7,608
Total Permanent Grass	**15,709**	**10,248**	**10,263**
Land temporarily out of use through flooding (a)	—	87	—
TOTAL ACREAGE OF CROPS AND GRASS (b)	**24,643**	**24,327**	**24,373**

contd.

CROPS AND GRASS (*thousand acres*) *contd.*

DESCRIPTION	*1939*	*1947*	*1948*
Rough Grazing—Sole rights	4,179	4,133	4,118
,, ,, —Common	1,361	1,436	1,436(f)
Total Rough Grazing	**5,541**	**5,569**	**5,554**

(a) Special question asked only in 1947.
(b) Excludes rough grazings.
(c) Not separately returned.
(d) Includes Turnips and Swedes for human consumption.
(e) Included under "Temporary Grass".
(f) Provisional.

SMALL FRUIT, VEGETABLES AND FLOWERS

(*thousand acres*)

DESCRIPTION	*1939*	*1947*	*1948*
Strawberries	18.7	13.0	16.1
Raspberries	4.1	2.4	2.8
Currants, Black	10.4	11.3	12.4
Currants, Red and White	2.3	1.5	1.5
Gooseberries	9.1	6.0	6.1
Loganberries and cultivated Blackberries	2.5	1.1	1.1
TOTAL SMALL FRUIT	**47.2**	**35.3**	**39.9**
Brussels Sprouts	38.0	50.7	54.7
Remaining Spring Cabbage (planted in 1947)	44.1	12.7	12.2
Summer Cabbage		10.9	11.4
Autumn Cabbage		7.7	8.5
Winter Cabbage		15.8	17.2
Autumn Savoys		6.7	6.2
Winter Savoys		21.2	17.0
Kale and Sprouting Broccoli		2.7	2.5
Cauliflower or Broccoli (Heading)	18.9	32.4	34.4
Carrots	16.1	33.2	34.6
Parsnips	(a)	5.3	8.9
Turnips and Swedes	(a)	12.7	9.2
Beetroot	(a)	10.9	11.1
Onions	1.7	11.3	14.8
Beans, Broad	17.8	3.9	6.2
Beans, Runner and French		12.3	12.8
Peas, Green for Market	60.6	51.1	54.4
Peas, Green for Canning	28.0	20.1	22.8
Peas, Harvested Dry		170.3	180.2
Asparagus	2.6	1.6	1.7
Celery	6.7	6.4	6.1
Lettuce	5.9	8.4	7.5
Rhubarb	7.2	8.0	8.5
Tomatoes (growing in the open)	0.2	2.8	3.2
Other vegetables growing in the open	(a)	15.1	14.4
All Crops growing in Glasshouses	3.3	3.7	3.7
All Crops growing in Frames		0.4	0.5
TOTAL VEGETABLES (excluding Potatoes)	**251.0**	**538.5**	**564.8**
Hardy Nursery Stock	10.5	7.9	8.3
All Bulb Flowers, not under glass	7.7	3.4	4.0
Other Flowers not under glass	5.8	4.7	5.7
TOTAL FLOWERS	**24.0**	**16.0**	**18.0**

(a) Not returned.

LIVESTOCK

(*thousand head*)

DESCRIPTION	*1939*	*1947*	*1948*
Cows and heifers in milk	2,255	2,250	2,278
Cows in calf but not in milk	392	513	516
Total	**2,646**	**2,764**	**2,794**
Heifers in calf, with first calf	459	661	709
Bulls for service	91	106	104
Bulls (inc. bull calves) being reared for service	43	44	45

contd.

AGRICULTURAL STATISTICS: ENGLAND AND WALES

LIVESTOCK *(thousand head) contd.*

DESCRIPTION	*1939*	*1947*	*1948*
Other Cattle two years old and over :			
Male (Steers)	(a)	449	438
Female	(a)	653	628
Total	**944**	**1,102**	**1,066**
Other Cattle one year old and under two :			
Male (Steers)	(a)	292	276
Female	(a)	933	889
Total	**1,346**	**1,225**	**1,165**
Other Cattle under one year old (excluding bull calves being reared for service) :			
Male (Steers)	(a)	279	356
Female	(a)	995	1,102
Total	**1,242**	**1,274**	**1,458**
TOTAL CATTLE	**6,770**	**7,175**	**7,340**
Sheep one year old and over :			
Rams for service	205	123	119
Ewes for breeding	7,160	4,087	4,317
Two-tooth (shearling) ewes	1,477	1,092	901
Other sheep one year old and over	1,021	950	806
Total	**9,863**	**6,252**	**6,143**
Sheep under one year old :			
Ram lambs for service	156	62	69
Other sheep and lambs under one year old	7,967	3,848	4,647
Total	**8,123**	**3,910**	**4,716**
TOTAL SHEEP AND LAMBS	**17,986**	**10,162**	**10,858**
Sows in pig	(a)	66	99
Gilts in pig	(a)	35	75
Other sows for breeding	(a)	44	75
Total sows for breeding	**449**	**146**	**249**
Barren sows for fattening	(a)	10	13
Boars for service	30	11	15
Young boars being reared for service	(a)	5(4.9)	9(8.6)
All other pigs :			
Five months old and over	633	400	395
Two to five months old	1,516	369	560
Under two months old	888	205	391
TOTAL PIGS	**3,515**	**1,146**	**1,632**
Fowls :			
Six months old and over	23,154	17,480	19,596
Under six months old	29,758	20,376	28,268
Fowls, Total	**52,912**	**37,856**	**47,863**
Ducks, Total	**2,237**	**1,963**	**2,335**
Geese, Total	**584**	**731**	**913**
Turkeys, Total	**693**	**511**	**742**
TOTAL POULTRY	**56,426**	**41,060**	**51,853**
Horses used for agricultural purposes :			
Mares (including those kept for breeding)	347	403	224
Geldings	202		160
Unbroken horses of one year old and over (Light)	110	61	17
" " " " (Heavy)			30
Horses under one year old (Light)	15	8	7
" " " " (Heavy)	35	11	7
Stallions being used for service (Light)	5(4.6)	2(2.0)	1(1.0)
" " " (Heavy)			1(1.3)
All other horses (not entered above)	132	113	90
TOTAL HORSES	**846**	**597**	**538**

(a) Not separately returned.

LABOUR

(thousands)

DESCRIPTION	*1939*	*1947*	*1948*
Regular Workers :			
Male, 65 years old and over	375.3	27.6	27.6
,, 21 years old and under 65		368.2	391.6
,, 18 years old and under 21	44.7	45.2	47.4
,, under 18 years old	50.8	50.6	39.9
Total	**470.8**	**491.6**	**506.5**
Women and girls	40.3	56.8	57.3
Total Male and Female	**511.1**	**548.4**	**563.8**
Women's Land Army	—	17.7	16.6
Prisoners of War	—	78.7	11.4
Casual Workers :			
Male, 21 years and over	57.4	76.4	90.4
,, under 21 years old	5.9	7.5	8.4
Total	**63.3**	**83.9**	**98.8**
Women and Girls	32.7	48.0	50.4
Total Male and Female	**96.0**	**131.9**	**149.1**
Total Male Workers	**534.1**	**654.2**	**616.7**
Total Female Workers	**73.0**	**122.5**	**124.1**
TOTAL WORKERS	**607.1**	**776.7**	**740.8**

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS INCLUDING GOVERNMENT GRANTS. (BASE 1927–29 = 100)

Month	Uncorrected for Seasonal Variation					*Corrected for Seasonal Variation*				
	1939	1946	1947	1948	1949	*1939*	*1946*	*1947*	*1948*	*1949*
January ..	95	199	217	241†	245†	*89*	*179*	*193*	*215†*	*218†*
February	94	201	211	240†	243†	*88*	*182*	*190*	*217†*	*220†*
March ..	91	192	201	232†	238†	*91*	*183*	*191*	*220†*	*225†*
April ..	90	176	186	214†		*95*	*182*	*192*	*222†*	
May ..	82	162	171	198†		*91*	*181*	*192*	*222†*	
June ..	80	161	170	197†		*89*	*181*	*193*	*225†*	
July ..	85	168	181†	198†		*93*	*182*	*197†*	*216†*	
August ..	86	176	192†	211†		*91*	*191*	*208†*	*228†*	
September	92	177	206†	210†		*93*	*188*	*222†*	*227†*	
October ..	96	192	221†	226†		*92*	*187*	*215†*	*221†*	
November	106	209	235†	239†		*98*	*192*	*217†*	*222†*	
December	113	214	241†	246†		*103*	*192*	*216†*	*221†*	

† Provisional.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the March, 1949, number of *Agriculture* (p. 548), the undermentioned publications have been issued.

Bulletins Copies are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

No. 21 Domestic Preservation of Fruit and Vegetables (*Revised*) 2s. 0d. (2s. 2d. by post)
No. 92 Chrysanthemums (*Revised*) 1s. 6d. (1s. 8d. by post)
No. 141 Fruit Growing Areas on the Hastings Beds in Kent (*New*) 1s. 3d. (1s. 5d. by post)

Advisory and Animal Health Leaflets Single copies of not more than 16 leaflets (four in any one group) may be obtained, free of charge, on application to the Ministry, 1-3 St. Andrew's Place, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from the Sales Offices of H.M. Stationery Office, net price 1d. each (2d. by post), or 9d. per doz. (11d. by post).

Group I. Livestock and Dairying
No. 33 Home Preservation of Eggs (*Revised*)

Group II. Pests and Diseases of Farm and Horticultural Crops
(b) Fungi
No. 340 Cucumber Mosaic (*New*)

Group V. Weeds
No. 345 Weed Control in Linseed and Flax (*New*)

Animal Health Leaflets
No. 9 Swayback in Lambs (*Revised*—superseding Advisory Leaflet No. 301)
No. 12 Blackhead in Turkeys (*Revised*—superseding Advisory Leaflet No. 20)
No. 13 Salmonella Infection of Poultry (*Revised*—superseding Advisory Leaflet No. 298)
No. 19 Trichomonas Disease (*Revised*—superseding Growmore Leaflet No. 90)
No. 21 Stomach Worms in Sheep (*Revised*—superseding Advisory Leaflet No. 275)

Other Publications
Technical Communication No. 8: DDT and the Apple Capsid Bug (*New*) Free
Management in Farming: Report of the Farming Management Conference at Winchester, February, 1949 (*New*) 1s. 6d. (1s. 8d. by post)

BOOK REVIEWS

Commercial Apple Growing. A. H. Hoare. The Bodley Head. 12s. 6d.

The second revised edition of this book has made its appearance after ten years—a period that has been crowded with changes in the many phases of commercial apple production.

Although relatively small, the author has packed this book with essential details and practical knowledge in a very readable form. Additional value lies in the fact that it links the result of research investigations with their practical application to modern methods of production. The work is principally concerned to assist the commercial fruit-grower, but it is of value to students at universities and farm institutes, and to those who contemplate fruit-growing as a livelihood. Young men coming into the industry are advised first to spend a year or so on the farm of a progressive grower, in addition to attending courses at an agricultural college or specialist farm institute.

In the chapter dealing with a survey of production, I doubt if everyone will agree that . . . "it would be fairly safe to say that we are near saturation point in the production of cooking apples. . ." There is less competition in cooking apples from overseas, but sales in this country could be improved by better grading and presentation. It is pleasing to note that the author has a good word for the commission salesman, for it is true that the closer the grower works with salesmen of repute the better for both parties.

There has been a tendency to market varieties before they are suitable in texture or quality, and the author rightly condemns this. "There is no surer way of losing public support for home-grown apples than this growing practice of stealing a march with our dessert apples."

C.H.O.

BOOK REVIEWS

Fat Lamb Production. UNIVERSITY OF LEEDS AND YORKSHIRE COUNCIL FOR AGRICULTURAL EDUCATION. Jowett and Sowry. (Free issue.)

Many farmers in the North are familiar with the Leeds University reports of experiments to ascertain the value of rams of different breeds for the production of fat lambs. The emphasis on livestock production in the expansion programme makes it opportune that the University is now able to carry the matter a stage further by publishing data on the significance of the breeding of the ewe in relation to the same problem. There is no doubt that grass sheep will play an important part in utilizing the extra grass produced and in maintaining fertility; and what is more important to the farmer than information on the right kind of sheep to use?

The experiments now reported compare the efficiency as mothers (for fat lamb production) of first-cross ewes obtained by crossing the Swaledale ewe with the Border Leicester, Suffolk, and Wensleydale ram, respectively. The Hampshire was used as the common factor in obtaining the second-cross lambs. Much valuable information is given, covering fertility, productivity, and longevity of the ewes, ability of the ewes to rear lambs, birth-weight of the lambs, age of lambs when sold, live-weight of lambs when sold, rate of live-weight increase of the lambs, carcass percentages, grading of carcasses, prices realized by the lambs, financial return per ewe, and gross average output per ewe. Farmers, advisers, and students will find this report well worth studying.

The results suggest that the Yorkshire hill farmer is not far wrong in looking with most favour on the Wensleydale-Swaledale cross, because this cross gave the best return in the admittedly limited scope of this part of the experiment. From the point of view of the farmer buying wether lambs (for turniping) from the hill first-cross, the evidence was in favour of the Suffolk-Swaledale cross, as measured by the sale value of the fat hoggs, but this advantage tended to be neutralized by food and labour costs, so that this particular farmer might well be content to accept wether lambs of any of the three crosses tried.

The most important conclusions are those referring to the provision of a first-cross ewe for the production of fat lambs on lowland grass over a period of several years. Here the hardiness, fertility, and maternal characteristics of the Suffolk won, and the Swaledale-Suffolk cross gave the highest gross return, beating the Wensleydale cross and the Border Leicester cross by £2 14s. and £3 15s. per head, respectively.

D.S.H.

Farm Life in a Yorkshire Dale: A Study of Swaledale. W. H. LONG and G. M. DAVIES. Dalesman Publishing Company. 5s.

For some people there is a forbidding quality about the study of economics, but when the subject-matter is presented in a bright and interesting way, as in this little book, it becomes truly fascinating reading.

Having sketched in a picture of this most beautiful of Yorkshire dales and told something of its history, including "the violent jolts" which its economic life has received from the lead mining industry, the authors proceed to a detailed description of its farming, now practically the only occupation of a local population whose numbers fell by 56 per cent between 1871 and 1931. The Dale has found it necessary to develop its agriculture from the traditional sheep and cattle rearing to a wider economy embracing milk selling, coupled with the export of young dairy stock. A great deal of financial information, based on the accounts of twenty farms is given in the book and its appendices. Profits are not large—no more than £390 per year on "milk" farms and £500 per year on "sheep" farms. This has to suffice for interest on capital, reward for enterprise, and recompense for manual work which, in the great majority of cases, takes up most of the farmers' time.

It is interesting, however, to note that the authors consider the rewards from this way of life to compare favourably with a farm worker's wages plus the returns from the investment in securities of an equal amount of capital. But this result is obtained only by cutting out all unnecessary cash outlay, including in most instances the "luxury" of a car; and the hill subsidies are indispensable. It will be encouraging to many who fear that this type of farming is in danger of extinction to note the authors' views that farming in Swaledale offers satisfactory opportunities for successful family farming.

The important conclusion is drawn, which should be noted in relation to other similar farming types, that any material reduction in returns would turn the scales against continuation of farming and tend to an increased rate of depopulation.

D.S.H.

Principles of Agriculture. W. R. WILLIAMS. Hutchinson. 15s.

It is often alleged that those who visit the U.S.S.R. generally return confirmed in their preconceived notions of what the conditions in that country are really like; that they have seen only what they expected to see, whether good or bad; that very few visit it with an open and unbiased mind, and fewer still, as a result of their visit, change a mind already made up.

To review a Russian book seems open to the same dangers, and demands special care that all prejudice should be avoided. The author begins by quoting with approval a dictum of Lenin's that bourgeois scientists had thought out the law of diminishing returns "in order to mask the capitalistic impediments to agricultural progress"! Comment of this sort is apt to prejudice a reader, and may result in his paying insufficient attention to a valuable book which contains some novel ideas and theories which, though admittedly controversial, are yet stimulating and worthy of serious consideration.

The title is misleading to us in this country who associate such titles with agricultural textbooks of a very different nature. This is not a textbook which could be read by the ordinary agricultural student for, though parts of it might be valuable to him, there are other parts that he could not understand, and much which would only confuse him. It is certainly not a book which could be recommended to farmers. Undoubtedly it should, however, be read by all who are interested in soil science. The ground covered by the book can be summarized by the author's own words:

"The whole science of agriculture is summed up . . . by firstly, the system of cultivation, the object of which is to produce a structural condition in the soil, accompanied by the least possible amount of soil dispersion. Secondly, the system of fertilising, in order to maintain the maximum quantity of mineral plant nutrients in the soil, and to convert them into organic forms. Thirdly, the system of restoring soil fertility, the object of which is to counteract the natural tendency towards a loss of structural stability in cultivated soils. And fourthly, the creation of a fodder base. These four systems embrace the whole range of agricultural knowledge."

W.S.M.

The Journal of Soil Science, Vol. 1, No. 1 (March, 1949). BRITISH SOCIETY OF SOIL SCIENCE. Oxford University Press (Geoffrey Cumberlege). 17s.

This important new annual journal, edited by G. V. Jacks, M.A., Director of the Commonwealth Bureau of Soil Science, exists for the publication in English of papers of a high scientific standard, either presenting the results of original research in the field of soil science or reviewing within this field. It is the organ of the recently-formed British Society of Soil Science, but its pages are open to research workers, whether within or outside the British Commonwealth.

The first number, of about 120 pages, presents eleven papers comprising studies of the electric charges carried by clay particles; the effect of weather and soil conditions on the loss of water from soil by transpiration; the correlation between climatic factors and the degree of soil leaching; various kinds of podzolic soils in Wales and north-east Scotland and frost soils on Mount Kenya; the movement of iron oxides in podzol soils; X-ray studies of soil clays and humification; and a review of present knowledge and future questions concerning lake sediments.

The Journal's attractive production should ensure a warm welcome for this newcomer from soil workers everywhere.

W.D.B.

Printed in Great Britain under the authority of HIS MAJESTY'S STATIONERY OFFICE
by C. Nicholls & Company Ltd., The Philips Park Press, Manchester, London and Reading.